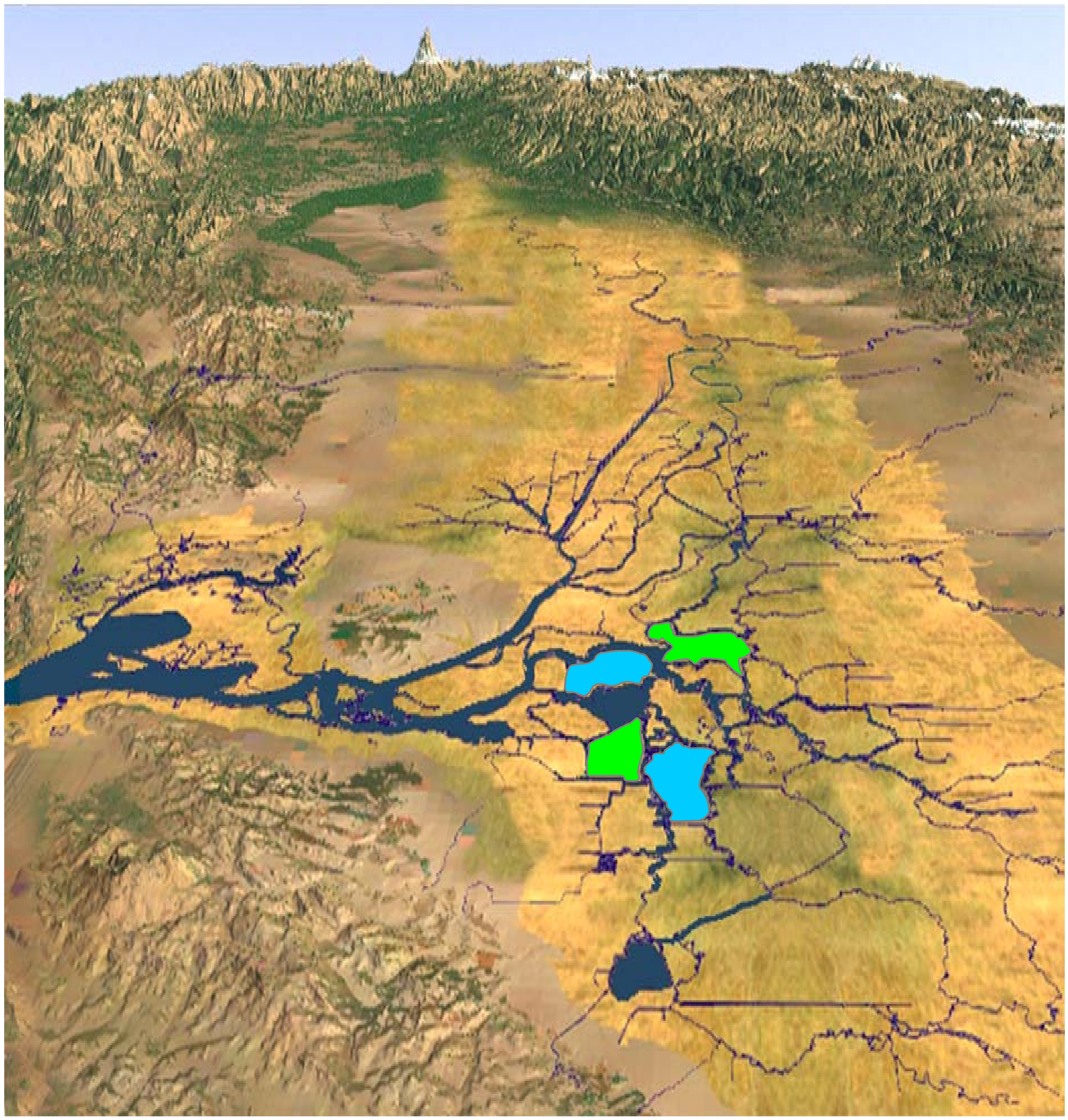
INTEGRATED STORAGE INVESTIGATIONS

IN-DELTA STORAGE PROGRAM DRAFT SUMMARY REPORT



CALFED
BAY-DELTA
PROGRAM

May 2002

IN-DELTA STORAGE PROGRAM

PREFACE

The mission of the CALFED Bay-Delta Program is to develop a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system. The CALFED program elements such as storage, conveyance, levee rehabilitation, the ecosystem restoration program and the water quality program are aimed at achieving balance in the Delta and meeting competing needs of the ecosystem and water users. Any future storage development in the Bay-Delta region should contribute to reducing major conflicts among beneficial uses of water. A resolution of issues in the Delta must be achieved.

Due to the vulnerable nature of the Delta soils, frequently changing water levels, and future potential for regional development, it is important that any potential storage projects be safe at maximum capacity, under extreme natural events, and should be durable. In addition to technical feasibility, the proposed storage project should be economically viable and beneficiaries must be willing to pay for it.

In-Delta storage development is a potential water management opportunity that could contribute to water supply reliability and help meet the Delta ecosystem restoration goals. The Bay-Delta region is an important link between the Sacramento River and the San Joaquin River basins and storage in this region could capture a portion of the available water which would otherwise end up in the San Francisco Bay and the Pacific Ocean. This opportunity cannot be availed without broad public acceptance.

The California Department of Water Resources (DWR) and the CALFED Bay-Delta Program, with technical assistance by the U.S. Bureau of Reclamation (Reclamation), have conducted a joint planning study to evaluate the Delta Wetlands (DW) Project and other in-Delta storage options for meeting CALFED water supply reliability and ecosystem restoration objectives. The main purpose of the investigations was to determine if the DW proposed project is technically and financially feasible for public ownership.

Based on the study evaluations (engineering, operations, water quality, environmental and economic) and engineering design review by the Independent Board of Consultants, DWR and Reclamation have concluded that the project concepts as proposed by DW are generally well planned. However, it is the conclusion of DWR and Reclamation that for ownership by these two agencies, the project as proposed by DW requires modifications and additional analyses before it is appropriate to “initiate negotiation with Delta Wetland owners or other appropriate landowners for acquisition of necessary property” (CALFED ROD, page 44).

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EXECUTIVE SUMMARY

1.1 Introduction

In-Delta storage investigations were authorized under the CALFED Integrated Storage Investigations Program as defined in the CALFED Bay-Delta Program Programmatic Record of Decision (ROD) and Implementation Memorandum of Understanding (MOU) signed on August 28, 2000, by State and Federal agencies (collectively, the CALFED Agencies). The ROD identified in-Delta storage as one of five surface storage projects (Shasta, Los Vaqueros, In-Delta, Sites Reservoir, and 250-700 thousand acre feet (TAF) of additional storage in the upper San Joaquin River watershed). As a part of the In-Delta Storage Investigations, CALFED Agencies also decided to explore the lease or purchase of the DW Project (Figure 1), a private proposal by DW Properties Inc. to develop and market a water storage facility in the Sacramento-San Joaquin Delta (Delta). The ROD included an option to initiate a new project if the DW Project proves cost prohibitive or technically infeasible.

The California DWR and the CALFED Bay-Delta Program, with technical assistance by Reclamation, have conducted a joint planning study to evaluate the DW Project and other in-Delta storage options for contributing to CALFED water supply reliability and ecosystem restoration objectives. The study consisted of six technical and financial feasibility evaluations of the DW Project: water supply reliability, impacts on water quality, engineering feasibility, environmental impacts, economic justification, and policy and legal. The main purpose of the investigations was to determine if the DW proposed project is technically and financially feasible. This report includes an executive summary and information on project descriptions, operation studies, water quality evaluations, engineering investigations, economic analyses, and policy and legal issues. Findings, conclusions and recommendations of this planning study and a future strategy for project implementation are also presented in this report.

While this report does distinguish between public and private ownership, it also acknowledges that under either design or operational criteria, all codes and applicable laws are followed in designing and operating the project. However, different choices may be made regarding design and operations that will influence the capital investment, risk assessment, and operations and maintenance costs.

1.2 Project Background

1.2.1 Purpose and Need for In-Delta Storage

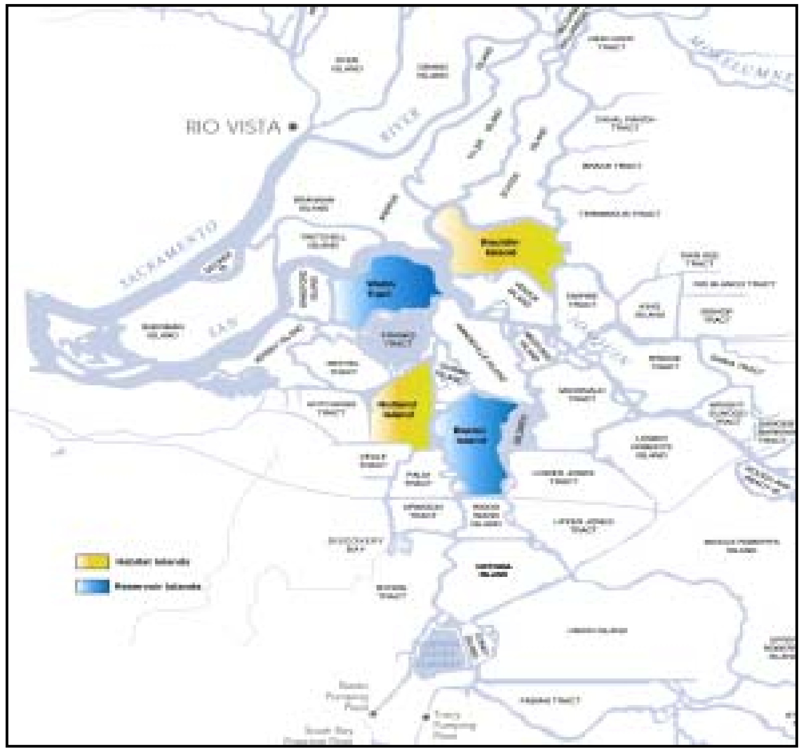
The purpose of in-Delta storage is to help meet the ecosystem needs of the Delta, Environmental Water Account (EWA) and Central Valley Project Improvement Act (CVPIA) goals, provide water for use within the Delta and increase reliability, operational flexibility and water availability for the south of the Delta water use by the State Water Project (SWP) and the Central Valley Project (CVP).

Improved operational flexibility would be achieved by providing an opportunity to change the timing of Delta exports and new points of diversion that could be selectively used to minimize impacts on fish. The DW Project would divert water from the Delta to in-Delta storage during periods of high flow and low impacts on fish. The stored water would allow curtailing export diversion at times most critical to the listed fish species. New storage in the Delta could be useful to the California water system for these reasons.

1. Increase water supply reliability.
2. Improve system operational flexibility.
3. Allow reservoir space to be temporarily used for water transfers and banking.
4. Allow water to be stored and released to meet CVPIA and EWA goals and water quality constraints.

5. Allow surplus water to be stored during wet periods and when upstream reservoirs spill, permitting water to be stored in the Delta and released into the San Joaquin River and other in-stream channels for fisheries during dry periods.

Figure 1: LOCATION PLAN DELTA WETLANDS PROJECT



1.2.2 Purpose of Habitat Islands

The purpose of the habitat islands is to mitigate project impacts by developing and protecting 9,000 acres of wildlife habitat on two habitat islands, Holland Tract and Bouldin Island. A Habitat Management Plan (HMP) will guide the development of habitat that will compensate for the loss of Swainson's hawk and greater sandhill crane foraging habitat, jurisdictional wetlands and wintering waterfowl habitat.

A conjunctive wildlife friendly agricultural use habitat is discussed in the DW HMP. A public owner may want to include modifications to agriculture crops, seasonal managed wetlands, pasture and emergent marsh, etc.

1.2.3 Record of Decision Timeline

The CALFED ROD established the following deadlines for the In-Delta Storage Program:

- Make decision whether to seek authorization for a feasibility study of alternatives (Federal funds) by October 2000.
- Select project alternative and initiate negotiations with DW owners or other appropriate landowners for acquisition of necessary property by December 2001.
- Develop project plan that addresses local concerns about effects on neighboring lands and complete any additional needed environmental documentation by July 2002.
- Complete environmental review and documentation, obtain necessary authorization and funding, and begin construction by the end of 2002.

In order to address the first deadline, DWR and Reclamation completed reconnaissance level studies of the DW Project and other alternatives and presented results in a joint report titled “ Summary Appraisal Report, Reclamation/DWR In-Delta Storage Investigations, November 2000”. This appraisal concluded that the DW Project could provide improved operational flexibility, unique to in-Delta storage, in meeting CALFED objectives by storing in-stream flow releases from upstream reservoirs to later meet Delta outflow requirements and enhance water reliability. The current study was initiated in January 2001.

1.2.4 Guiding Principles

The CALFED Bay-Delta Program was established in 1995 to develop a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system. CALFED agencies, including DWR and stakeholders[1], have committed to develop a balanced plan to restore ecosystem health, improve levee stability in the Delta, and improve water quality and water supply reliability. A set of principles was developed to achieve this balanced plan. In brief, CALFED's principles direct programs to: reduce conflicts among beneficial uses of water, be equitable, be affordable, be durable, able to be implemented and impose no significant redirected impacts.

The following guidelines were developed based on these principles for evaluation of the In-Delta Storage Program.

1.2.4.1 Achieve Resolution of Issues

The proposed project must contribute to reducing major conflicts among beneficial uses of water in the Bay-Delta system.

1.2.4.2 Storage Program Needs

A storage program will be developed to provide water supply reliability, system flexibility and meet Delta ecosystem needs. CALFED's policy of willing seller and willing buyer will be used to develop and screen alternatives. The proposed project should be technically feasible as a public ownership project.

1.2.4.3 Safety and Public Health

All projects should meet safety and public health requirements at maximum capacity, under extreme natural events and should be durable.

1.2.4.4 Economic Viability

The project should be affordable and financially feasible. CALFED's concept is "beneficiaries must pay for the project" and a beneficiary will pay only if the benefits of the project are realized.

1.2.4.5 Implementation

Solutions will have broad public acceptance, conform to all legal requirements, and be capable of timely implementation.

1.2.4.6 No Direct Significant Impacts

All reasonable alternative solutions will be considered. Solutions will not solve problems in the Bay-Delta system by redirecting significant negative impacts to other parts of the Bay-Delta or regions of California.

1.3 Scope of Present Evaluations

The main purpose of the investigations presented in this report is to determine if the DW Project is technically and financially feasible for public ownership. As provided in the CALFED ROD, in case the project is infeasible or cost prohibitive, other available options for a "new project" are to be considered, including a redesign or reconfiguration of the DW Project. During the State Water Resources Control Board (SWRCB) DW Year 2000 Hearings, stakeholders and adjacent landowners raised several issues. Investigations focused on the following major issues identified during these hearings:

[1] Stakeholders are any individual or group with an interest in the In-Delta Storage Project.

- Water supply reliability, flexibility and yield of the project
- Water quality impacts at the urban intakes and in Delta channels
- Engineering design, risk of failure due to operations, seismic and flooding events including seepage and associated costs
- Environmental impacts, monitoring and mitigation
- Economic feasibility of the project
- Policy and legal implications and California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA) requirements

The issues listed above were addressed during the DW water rights hearing, and the hearings provide a basis for the scope of this analysis. However, while permitting regulatory agencies may be satisfied that these issues have been resolved, the hearings did not include an evaluation of the financial and technical feasibility of the DW Project. The scope of studies conducted to explore these issues to the satisfaction of DWR and Reclamation is briefly stated in the following sections.

1.3.1 Operational Studies

Water supply yield from the in-Delta storage reservoirs was estimated with the newly developed California Simulation Model-II (CALSIM-II) daily Delta operations model. Calculating the yield using a daily model is important because the water quality standards restricting the project must be met on a daily basis rather than a monthly one. The CALSIM-II model synchronized north of Delta reservoir operations on a monthly basis and simulated diversion of Delta surplus flows using a daily time step after meeting all the Delta requirements and standards. South of the Delta operations are based on monthly operations using 2020-level water demands. Information on water supply evaluations is summarized in Chapter 3, Operations Studies. A separate May 2002 report provides details on modeling procedures titled, “In-Delta Storage Program, Draft Report on Operation Studies.”

Operational flexibility and reliability are important factors for the State Water Project, CVP and provisions for the Delta water requirements. Operational constraints of meeting the Delta water quality and flow standards include:

- SWRCB Decisions 1641 (1995 Water Quality Control Plan)
- CVPIA including Vernalis Adaptive Management Plan
- DW Permit Decision 1643, operational and water quality requirements
- Department of Fish and Game (DFG) Incidental Take Permit, and National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) Biological Opinions
- Water Quality Management Plan (WQMP) Agreement between California Urban Water Agencies (CUWA) and the DW Properties
- Protest dismissal agreement between the Contra Costa Water District (CCWD) and the DW Properties
- Protest dismissal agreement between the East Bay Municipal District and the DW Properties
- EWA
- In-Delta Consumptive Use

Available Delta flows (in the base condition without the project) can be diverted to island reservoirs. In addition, upstream and downstream water users can negotiate transferring water supplies from north to south or banking water temporarily. Climate changes may occur over the life of the project. A preliminary assessment of the impact of this change on the project was included in this study.

1.3.2 Water Quality Evaluations

Water quality investigations included the following field, laboratory and modeling studies:

- Field soil and water sampling
- Laboratory experimentation and analyses
- Bio-productivity studies
- Water temperature and dissolved oxygen (DO) studies
- Water quality modeling studies

DWR conducted the field water quality investigations under the Department's Municipal Water Quality Investigations Program (MWQI). Soil and water samples collected from Webb Tract and Bouldin Islands were analyzed in DWR's Bryte Laboratory, Special Multipurpose and Research Technology Station (SMARTS). Information from experiments combined with conceptual models and algorithms was used to predict the changes in organic carbon concentrations in the DW proposed reservoirs from peat soils. Environmental Research Associates conducted bio-productivity studies to predict the organic carbon component related to algae and aquatic plant bio-productivity activity. Water temperature and DO studies were conducted by Reclamation to predict the temperature and DO differences in reservoirs and channels.

The DSM2 Water Quality Model was applied to assess compliance with organic carbon, salinity and other standards imposed by the SWRCB and WQMP. However, DSM2 did not assess temperature and DO. Summary information on water quality studies is presented in Chapter 4. Details of field investigations and DSM2 modeling are in a separate report titled, "In-Delta Storage Program Draft Report on Water Quality Investigations," May 2002.

1.3.3 Engineering Investigations

The purpose of the engineering investigations was to evaluate the adequacy of the proposed DW Project design assuming public ownership of the project. The scope of work included detailed engineering investigations conducted jointly by Reclamation and DWR to evaluate the technical feasibility of the DW Project as proposed and, where appropriate, investigate alternative modifications for improvements to the DW proposal. To perform this evaluation, Reclamation/DWR used the information contained in the DW Environmental Impact Report/Environmental Impact Statement (EIR/EIS) and in other reports pertaining to the DW Project along with new design analyses and field information, such as mapping and geotechnical explorations, performed by Reclamation/DWR during summer and fall of 2001.

The focus of Reclamation/DWR evaluations was on the following areas:

- Project hydrology
- Field geotechnical and mapping investigations
- Evaluation of the DW proposed embankment design
- Risk assessment for potential failure of the DW Project due to operational, seismic, and flood events including seepage to adjacent islands
- Technical viability of the DW Project proposed fish screens, siphons and pumping stations structures
- New design criteria based on Reclamation and DWR standards
- Reclamation and DWR proposed designs for embankments and structures in relation to improvements in design for a re-engineered project or a reconfigured project
- Estimation of project quantities and costs
- Overall project evaluation

URS and CH2M HILL performed risk analyses and evaluations of the proposed DW fish screens, siphons and pumping stations, respectively. Separate reports are available on these studies. A summary of engineering studies is presented in Chapter 5 of this report. Details of engineering investigations are presented in a report titled, "In-Delta Storage Program Draft Report on Engineering Investigations," May

2002. Sea level rise due to climate change may increase project cost over time and this evaluation is included in the study.

1.3.4 Environmental Evaluations

The following evaluations were included in environmental studies undertaken for the in-Delta Storage Program:

- Preliminary environmental surveys and field studies including terrestrial and biological resources, cultural resources, recreational use and land use
- Environmental evaluations related to the development of habitat management plans for the DW Project and alternatives considering public ownership
- Fish screen evaluations
- Environmental impact assessments
- Monitoring and mitigation plans and costs
- An assessment of alternatives based on potential impacts, mitigation requirements and permit complexity

A summary of the environmental evaluations is presented in Chapter 6 of this report. Details of these investigations are given in a separate report titled "In-Delta Storage Program Draft Report on Environmental Evaluations," May 2002.

1.3.5 Economic Analyses

Economic analyses included assessment of the following:

- Evaluation of Equivalent Annual Cost of project implementation including costs of project development, construction, mitigation and operation and maintenance
- Benefits as a result of increased project exports, operational flexibility, CVPIA(b)(2), EWA and potential for water transfers
- Impacts on the Delta regional economy due to loss of agricultural lands and recreation
- Qualitative description of institutional/social ramifications, environmental impacts, water quality impacts, supply re-allocation, recreational and other benefits

Further information on economic evaluations is presented in Chapter 7 of this report. As all benefits of the project could not be evaluated in monetary terms, a benefit cost ratio was not assigned. Further evaluations will be required to determine economic feasibility of the project. Further details on economic analyses are presented in a separate report titled "In-Delta Storage Program Draft Report on Economic Analysis," May 2002.

1.3.6 Policy and Legal Implications

The scope of work for assessment of policy and legal implications of DW Project implementation and additional requirements if an alternative project is implemented, is as follows:

- Applicability of the DW EIS/EIR and permit applications to CALFED under 1) purchase, 2) lease, or 3) water banking agreement arrangements
- 404 permit application/alternative analysis
- Review the relationship of the project to the CALFED Programmatic EIS/EIR
- Additional CEQA/NEPA compliance and permits necessary under these alternative implementation arrangements
- Analysis of potential service area impacts
- Integration with SWP/CVP operations, limitations under various arrangements and NEPA/CEQA and permit processes required to expand operations

- State/federal liability for such issues as seepage, project island levee failure, and loss of agricultural lands
- Methodology for acquisition of a private water project by public agencies

A summary evaluation of policy and legal issues is presented in Chapter 8.

1.4 Findings, Conclusions and Recommendations

A project evaluation was conducted consistent with the CALFED ROD directive to review the DW Project. DWR and Reclamation reviewed information provided by the DW Properties Inc., including information presented in the EIS/EIR. It is recognized that any large project undergoes modifications of project features and design details throughout the various phases of development. It is also recognized that a public owner may make different choices regarding design and operations that will influence the capital investment, risk assessment, and operations and maintenance costs. The current analysis anticipates such changes.

Based on the evaluations done through engineering, operations, water quality, environmental and economic studies, and engineering design review by the Independent Board of Consultants, DWR and Reclamation have concluded that the project concepts as proposed by DW are generally well planned. However, it is the conclusion of DWR and Reclamation that for ownership by these two agencies, the project as proposed by DW requires modifications and additional analyses before it is appropriate to "initiate negotiation with Delta Wetlands owners or other appropriate landowners for acquisition of necessary property" (CALFED ROD, page 44).

The key findings of the studies that form the basis for the above conclusion along with the recommendations for the future action are presented in the following section.

1.4.1 Engineering Investigations

1.4.1.1 Key Findings and Conclusions

Based on the engineering design review, risk analyses and evaluations completed for the proposed fish screens, siphons and pumping stations of the DW Project, the following conclusions were made:

- The proposed conceptual design for embankment for Webb Tract and Bacon Island does not meet DWR and Reclamation standards for public ownership.
- Inlet and outlet structures as proposed by DW are not structurally sound and need modifications.
- Analyses conducted to assess the risk of embankment failure due to operational, seismic and flooding events concludes that some risk of failure exists in all three areas. Overtopping of the proposed embankments on Webb Tract and Bacon Island may occur during a 100-year flood. Consequences of failure could be similar to the existing conditions and could include salinity intrusion, interruption in reservoir operations, and impacts to biological resources, including fish entrainment.
- Due to the potential for seepage pumps to not operate during power outages, improvements in the proposed seepage control system should be investigated.
- Global warming and sea level rise may add additional constraints for the embankment as designed. Embankments may need to be raised to meet water level changes due to potential climate change.

1.4.1.2 Recommendations

- Solutions should be developed to enhance project reliability through improved design and consolidation of inlet and outlet structures.
- Embankment performance reliability can be improved with appropriate changes such as flatter slopes, wider crest, and possibly higher embankment. These and other solutions leading to overall system improvement are technically feasible and should be part of future studies.

1.4.2 Operation Studies

1.4.2.1 Key Findings and Conclusions

Operational modeling studies conducted using the SWRCB, WQMP, and DFG and USFWS criteria indicate:

- Based on the 73-year historical period daily modeling with a 2020 level of development and hydrology, DW Project provides an average annual increment in south of the Delta SWP and CVP water supplies of 126 TAF/year. This estimate is primarily for comparison purposes only and does not include reductions in water supply to meet delta smelt and WQMP criteria. The DW Project can also be operated for priorities other than augmenting south of Delta SWP and CVP water supplies.
- Based on the preliminary modeling for the 1975 to 1991 period, USFWS 1997 Final Operations Criteria (FOC) for the decline in delta smelt abundance is expected to reduce the yield of the DW Project by 20 TAF.
- Based on preliminary modeling, a yield reduction is expected in addition to the delta smelt criteria to comply with the WQMP requirements.
- Preliminary climate change assessment shows in-Delta storage will be effective in capturing early winter flows resulting from the change in flow patterns due to potential climate change.

1.4.2.2 Recommendations

- Further evaluations are needed to allocate water supply benefits between south of Delta exports, EWA, CVPIA, water banking and transfers. Daily CALSIM-II modeling should continue for a quantitative determination of project water use for environmental, CVPIA and other purposes in addition to South of Delta exports.
- There is a need to hold further discussions on the fisheries criteria application in light of DW Project being included as a CALFED project.

1.4.3 Water Quality Evaluations

1.4.3.1 Key Findings and Conclusions

Field investigations and water quality modeling studies were conducted to estimate total organic carbon (TOC), chlorides, bromides, salinity, temperature and DO parameters. Water quality constraints on these constituents are stated in the SWRCB and WQMP Agreement with CUWA. Water quality studies indicate that:

- Predicted dissolved organic carbon (DOC) concentrations from the peat soils range from 6 to 19 milligrams/liter (mg/l) in the proposed reservoirs.
- The contribution from bioproductivity for DOC is expected to range from 1 to 6.5 mg/l and the high range may reach 5 to 50 mg/l under drained conditions.
- DSM2 model simulations of the DW Project operations sometimes exceed WQMP DOC and disinfection by-products criteria at the urban intakes. Reductions in the estimated yield of the DW Project could occur to fully comply with the criteria.
- Based on a limited study of a 3-year time period, temperatures in the proposed reservoirs may be 1 to 9°F higher than the Delta channels. This may limit releases of stored water into the channels during low flow periods.

1.4.3.2 Recommendations

- Undertake additional modeling studies to evaluate project re-operations that are more effective in meeting SWRCB Decision 1643 criteria and WQMP criteria for DOC, chloride, temperature, DO, and disinfection by-products. Studies should also consider reservoir biological productivity.
- Develop laboratory methods to correlate soil characteristics with organic carbon release.
- Conduct experiments to investigate the complex ecology that may affect plant growth and carbon export from the reservoir islands.

1.4.4 Environmental Evaluations

1.4.4.1 Key Findings and Conclusions

Land use, resources, hazardous materials and recreation studies indicate:

- No mitigation for impacts to agricultural land is included in the DW Project. The CALFED ROD requires that all projects minimize impacts to agricultural land as necessary.
- Preliminary assessment of hazardous materials site conditions performed by DWR on Bouldin Island, Holland Tract, Webb Tract, and Bacon Island indicate that portions of the islands will require remediation before they can be used for either reservoir storage or habitat mitigation.
- DW Project proposes private use recreational facilities that are not appropriate for a publicly owned and operated project. The recreation plan should be modified to provide recreational benefits to the general public through a range of opportunities.
- The DW Project screen design developed in 1997 does not meet the DFG 2000 Fish Screening Criteria. The proposed fish screens will therefore require modifications to meet the current screening criteria.

1.4.4.2 Recommendations

- The DW project should be evaluated for consistency with the Farmland Protection Policy Act and modified to minimize impacts from loss of agricultural lands as necessary for public ownership.
- Environmental Site Assessment should be completed to establish potential responsibility and estimated costs for future cleanup and remediation.
- Alternative fish screens should be evaluated for compliance with the 2000 DFG Fish Screening Criteria.
- Additional botanical and wildlife surveys should be conducted to gather data necessary for biological assessments (Action Specific Implementation Plans) and future CEQA/NEPA documents required for either the Re-engineered DW Project, the Bacon Island and Victoria Island storage and connection to Clifton Court alternative, or other reconfigurations.

1.4.5 Economic Analyses

1.4.5.1 Key Findings and Conclusions

Economic analyses of costs, benefits and economic impacts of in-Delta storage alternatives indicate:

- The estimated total capital cost of development of the technically feasible Re-engineered DW Project is $662 million. Depending on the extent of cost variations due to various factors such as changes in design, unit costs, site conditions and construction methods, this cost may increase to $ 1.1 billion.
- Only a partial assessment of benefits resulting from incremental water supplies could be performed with the present available information on water use. At this stage of the analysis, allocations for various uses are not known. Further studies are required for complete evaluation of allocations between SWP and CVP, environmental, CVPIA, water banking, transfers and recreation.

- DW Project will have minimal adverse economic impact on the region because of lost agricultural lands due to the fact that agricultural losses are offset by increased recreation and income from maintenance jobs. Inclusion of Victoria Island as alternative storage to Webb Tract or Bacon Island indicates high adverse impact on the Delta economy.
- The Victoria Island Reservoir alternative with connection to Clifton Court has higher capital cost of development in comparison to the Re-engineered DW Project due to additional costs for raising Highway 4 and a new structure required for connection to Clifton Court.
- Annual Operation and Maintenance costs for the Re-engineered DW Project and the Victoria Island alternatives are approximately $8.4 million.

1.4.5.2 Recommendations

- Additional technical evaluations pertaining to operations, water quality, environmental, and risk analysis are recommended to finalize the design and cost associated with the acceptable level of design.

- Further economic studies of project benefits including allocations of DW water supplies and storage to SWP, CVP, environmental water, CVPIA, water banking, transfers and recreation are recommended.

2.1 In-Delta Storage Alternatives

2.1.1 Delta Wetlands Project

The DW Project as proposed by DW Properties includes conversion of: (1) Webb Tract and Bacon Island into storage reservoirs, termed “reservoir islands,” and (2) conversion of Bouldin Island and Holland Tract into “habitat islands.” The DW Project proposed seasonal diversions onto “habitat islands” for wetlands and wildlife management and enhancement for environmental mitigation (Figure 1). The storage capacity of the “reservoir islands” is estimated to be 217 thousand acre-feet (TAF) with a designated water surface elevation at 4 feet above mean sea level (MSL). DW Properties submitted a Draft EIR in 1995 to the SWRCB pursuant to water rights filings. The EIR was revised in July 2000 and a water right permit was issued in February 2001. Maximum permitted diversion onto the reservoir islands and habitat islands is 9,000 cubic feet per second (cfs) and the maximum allowable release is 6,000 cfs. DW used a maximum diversion of 5,900 cfs including the habitat islands in their study. The U.S. Army Corps of Engineers (USACE) approval of the EIS to meet the 404 permit requirement is pending. The locations of the diversion and release stations are shown in Figure 2.

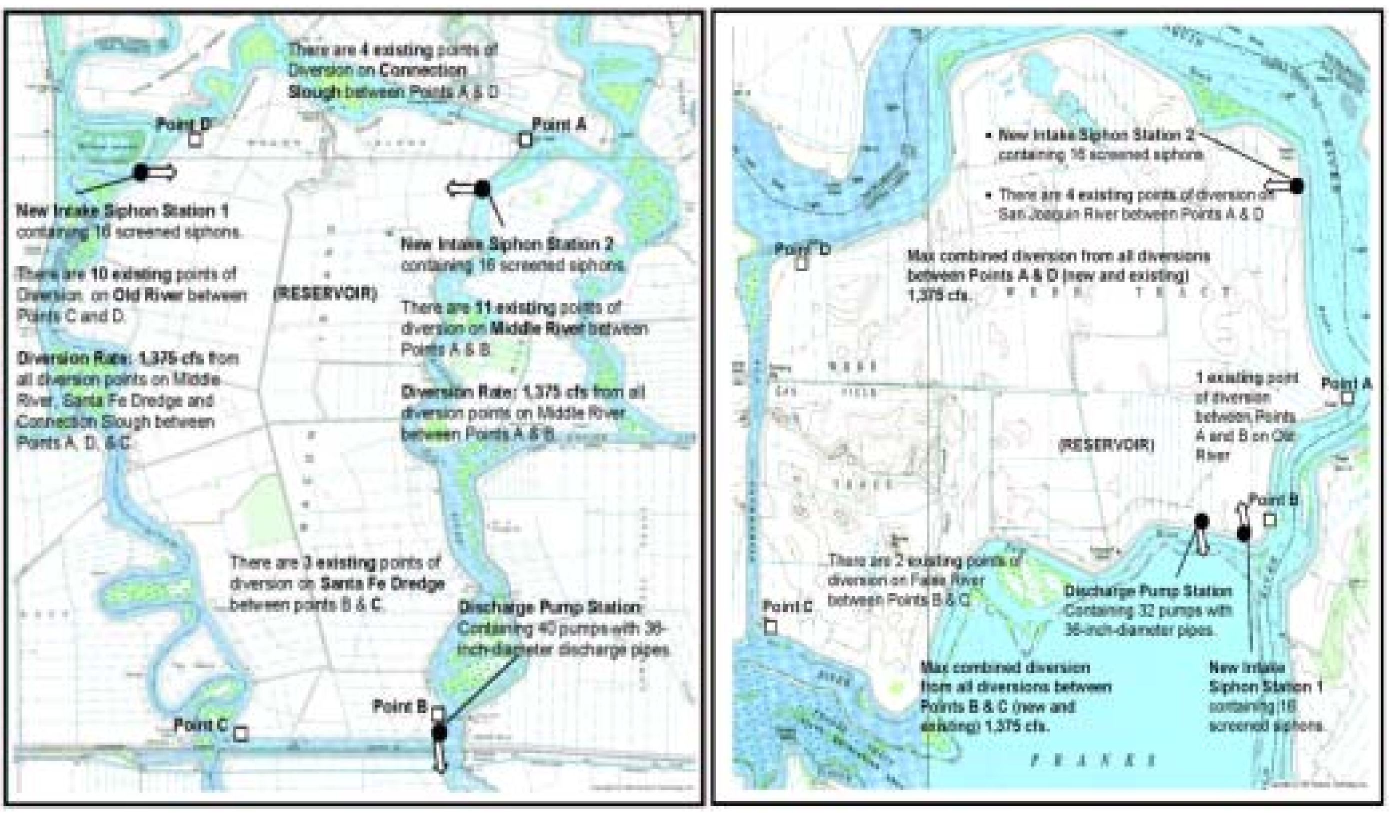


Figure 2: DELTA WETLANDS PROJECT

The DW Project proposed raising existing levees, widening crest width, flattening reservoir side slopes and providing slope protection for an improved new embankment section. Details presented in Harding Lawson Associates (HLA) 1989 report, URS Consultants review of the 2000 EIR and the final 2001 EIS documents, indicate a final embankment section with crest width of 22 feet and either 5:1 reservoir side slopes or variable slope of 3:1 for upper portion of the embankment from crest to minus 3 feet MSL and then slope changes to 10:1 for the lower section.

For the diversion of water, each reservoir island would have two new siphon stations consisting of 16 siphons each (64 siphons total). The siphons would be 40 feet apart and would be equipped with booster pumps, flow meters, and barrel type fish screens. In addition, 35 existing siphons on the perimeter of the reservoir islands would be modified with new fish screens.

For the release of stored water, each reservoir island would have a new discharge pump station consisting of 32 pumps at Webb Tract and 40 pumps at Bacon Island. To prevent seepage of stored water onto the neighboring islands, 773 pumps would be installed around the reservoir islands to intercept and pump water back into the reservoirs.

Diversion of water onto habitat islands will be accomplished through modified existing siphons. There would be 14 siphons on Bouldin Island and 8 siphons on Holland Tract. All siphons would have new fish screens similar to those installed at the reservoir islands. Counting siphons on both the reservoir and habitat islands, DW proposed 193 diversion and release structures.

2.1.2 Re-engineered DW Project

As part of the project alternatives evaluation and for the purpose of improving the DW Project operations, Reclamation/DWR considered a re-engineered alternative. This alternative includes the same

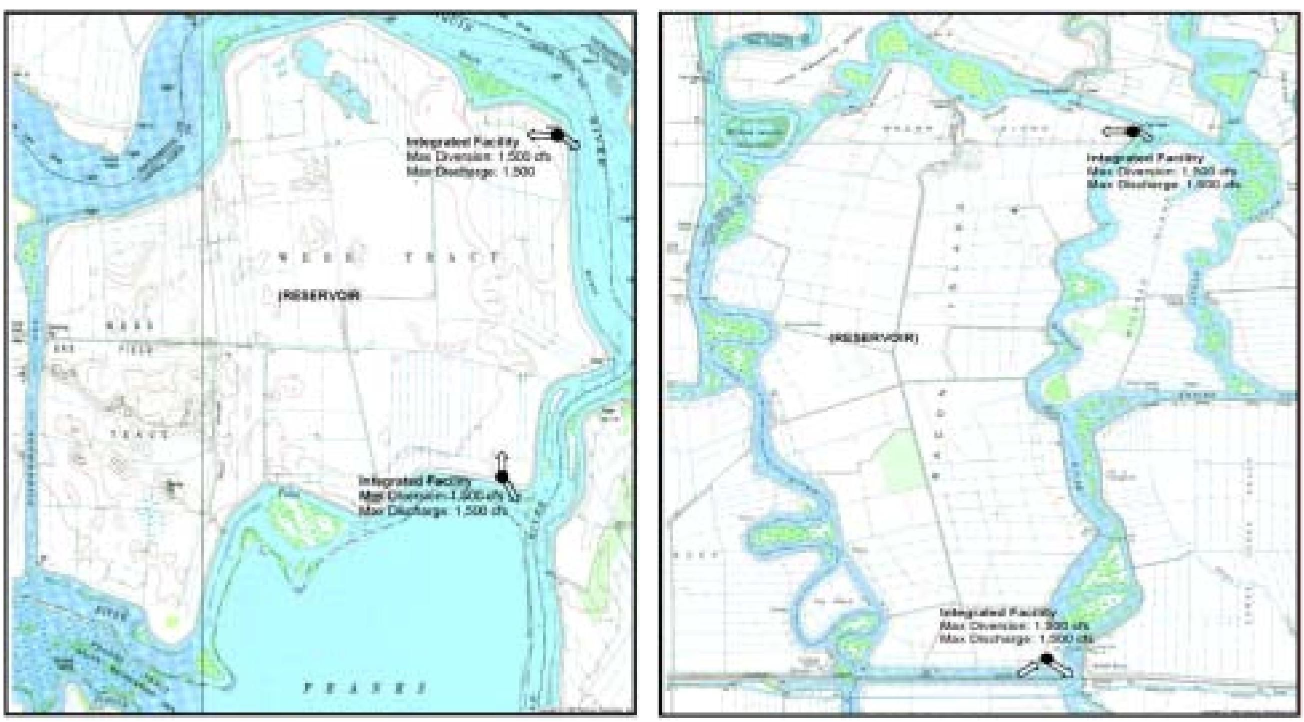


Figure 3: RE-ENGINEERED DELTA WETLANDS PROJECT

reservoir islands and habitat islands as the DW Project but changes the design of the levees and consolidates the 99 diversion structures and 72 discharge pumps for releases of water into four integrated facilities, shown in Figure 3.

2.1.3 Victoria Island with Connection to Clifton Court

To further improve the DW Project operational flexibility, another management option has been considered with Bacon and Victoria Islands for storage and also provides for a direct connection of Victoria Island to Clifton Court. In this case, Bacon Island and Victoria Island are the “reservoir islands” and diversion and release of water would be realized through the use of two integrated facilities and also water will be siphoned directly from Victoria Island to Clifton Court by gravity or pumping through a new siphon and pumping combination conveyance structure. Webb Tract, Bouldin Island and Holland Tract become habitat or agricultural islands in this proposal. Webb Tract could be considered as a habitat island or habitat to meet the goals of the Ecosystem Restoration Program Plan as long as the action is consistent with the Delta Ecosystem Restoration Implementation Plan. The integrated and conveyance facilities are shown in Figure 4. The second version of this alternative considered for analysis is a combination of Victoria Island with Webb Tract for storage. Pertinent features of in-Delta reservoir storage options are given in Table 1.

The Delta Protection Commission (DPC), a project stakeholder, has suggested further investigations on the possibility of using Sherman and Twitchell islands for environmental and agricultural mitigation.

2.2 Past Studies

There have been numerous studies of Delta water quality improvement, salinity control, water management, and storage and conveyance. Recently, DWR, Reclamation, the USACE, CALFED and consultants have studied in-Delta storage proposals or similar concepts of flooding Delta islands for intermittent storage. Information on recent studies follows:

2.2.1 Delta Wetlands Project

DW Properties filed its first water right application for the DW Project on July 9, 1987. In 1995, DW Properties completed studies for the draft EIR. In its application, the total storage capacity of the two reservoir islands was 238 TAF with designated water surface elevation 6 feet above MSL.

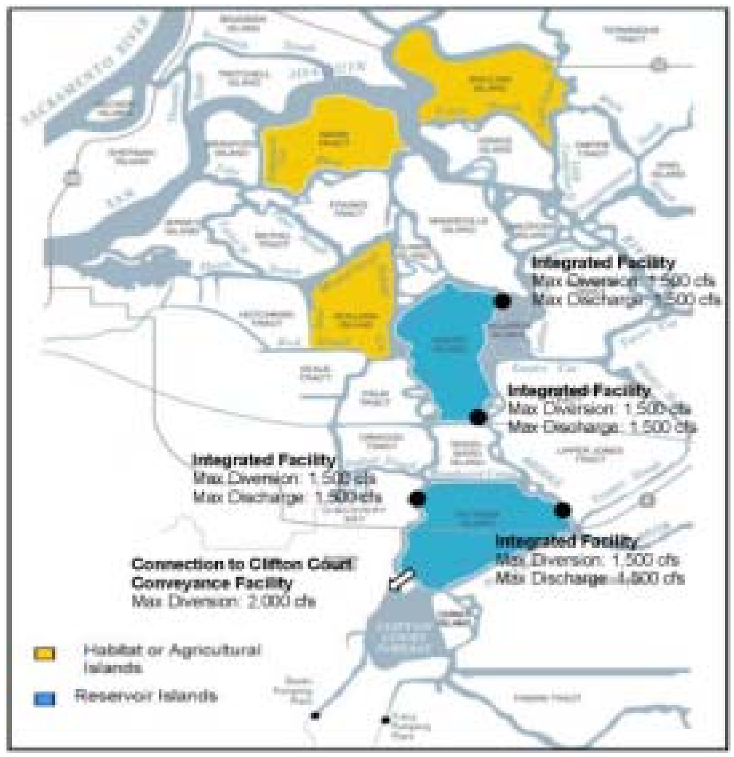


Figure 4: VICTORIA AND BACON RESERVOIRS WITH CONNECTION TO CLIFTON COURT

Jones & Stokes Associates Inc. prepared a Draft EIR/EIS for the DW Project in 1995 for the SWRCB and USACE. The Draft EIR/EIS was released for public review and in 1997. The SWRCB convened water right hearings to hear pro and opposing views on the DW Project, but no decision was granted. The USFWS issued a conditional "biological opinion" in May 1997 and DFG, in August 1998. This provided operating criteria for the project. In October 1998, DW requested SWRCB certification of the project under Section 401 of the federal Clean Water Act (CWA), a necessary prerequisite to issuance of a CWA Section 404 permit by the USACE. SWRCB conducted hearings in March, July and August 1997. In a letter dated November 25, 1998, the executive director of the SWRCB advised DW Properties of the concerns and the inadequacies. However, the board's review of the 1997 hearing record revealed substantial remaining uncertainty regarding several significant issues, such as protection of CCWD's senior water rights, constraints to protect water quality in the receiving water, control of seepage between islands, levee stability and relocations. The SWRCB also indicated that with mitigation, the DW Project yield for an average year could drop to 154 TAF from the original estimated yield of 235 TAF and it may even be less with further restrictions.

In May 2000, Jones & Stokes prepared a revised EIR to address significant issues of CVPIA (b)(2) application, water quality and proposed mitigation for environmental impacts. DW Properties resubmitted this revised EIR to SWRCB. The revised EIR did not change island storage of 238 TAF with a designated water surface elevation 6 feet above MSL. Fish screens were added to the intake pumps. Levee sections were the same as in the previous EIR. The DW Project average annual yield of 147 TAF was based on Jones & Stokes Associates daily SOS Model. SWRCB held hearings in October 2000 and SWRCB adopted Decision 1643 on February 15, 2001, issuing the DW water rights permit.

In July 2001, Jones & Stokes submitted the DW Final EIS to USACE and a decision under the 404 process is pending.

2.2.2 U.S. Corps of Engineers Study

In 1987 the USACE conducted studies on Delta levees liquefaction problems. The findings are in a report titled *Sacramento – San Joaquin Delta Levees Liquefaction Potential*. This study identified Webb Tract as having high liquefaction potential and Bacon Island levees as having moderate liquefaction potential. The 1987 report also identified that both islands have undergone earthquake damage. A 250-foot slip occurred on the east levee of Bacon Island following a 5.5 magnitude Livermore earthquake on January 24, 1980. Levee cracking was reported on Webb Tract after 1983 earthquakes in Pittsburgh and Coalinga.

2.2.3 CALFED South Delta Storage Studies

CALFED Storage and Conveyance Refinement Team conducted storage studies in 1997. Details of these studies are available in CALFED's October 1997 Report on *Facility Descriptions and Updated Cost Estimates, Volume 3*. The studies were conducted to provide information for CALFED's programmatic evaluation and were not intended to replace project specific investigations. The report summarized information on the principal features, estimated costs and environmental considerations of the project. The in-Delta storage project considered by CALFED consisted of a storage facility of 219 TAF with three Delta islands; Bacon, Woodward and Victoria, to be filled with water directly from the Delta. Maximum water surface elevation was assumed to be at 4 feet above MSL. Two alternative configurations were evaluated. The first alternative would maintain each of the three islands as separate storage compartments joined by siphons beneath the artificial Delta channels separating them. The second alternative would join the three islands into a single storage reservoir, eliminating the need for siphons. Both alternatives included improvements to the CVP and the State Water Project Delta pumping facilities. A 15,000 cfs pumping station to convey water from Victoria Island to Clifton Court was included in the configuration.

Primarily CALFED staff and consultants developed the costs for the CALFED South Delta Storage Project. This was also aided by reviewing and incorporating cost items found in previous reports including the 1990 DWR report titled *North Delta Program Draft EIR/EIS* and the 1995 DWR report titled *Isolated Transfer Facility Cost Estimate*.

2.2.4 Reclamation's Delta Wetlands Appraisal Study

Reclamation has published a report titled *Delta Wetlands Appraisal Report* in April 2000 based on information about the DW Project. The purpose of the appraisal study was to determine the potential viability of the DW Project as a joint federal/state project. In making that determination, the study focused on the following:

- Determining the project's water supply capability
- Comparing acre-foot of supply project cost with other water supply options
- Identifying critical issues that would limit project implementation and operation
- Recommending future federal actions

The Reclamation appraisal study report concluded that the DW Project could provide operational flexibility, unique to in-Delta storage, in meeting CALFED objectives by storing instream flow releases from upstream reservoirs to later meet Delta outflow requirements and enhance water reliability. It was recommended that Reclamation should seek Congressional authorization and funding for a feasibility investigation of the DW Project. The report mentioned ongoing CALFED Integrated Storage Investigations and stated results of CALFED's evaluation of in-Delta and off-aqueduct storage will help Reclamation determine the need for further detailed planning studies.

2.2.5 Reclamation and DWR In-Delta Storage Studies

Both agencies conducted joint reconnaissance level studies for in-Delta storage alternatives. A joint report titled "Summary Appraisal Report Reclamation/DWR In-Delta Storage Investigations" November 2000, was submitted to obtain authorization for a feasibility study. Also a Draft Executive Summary Report by DWR published in September 2000 is available on these studies. Various island combinations in addition to islands owned by DW Properties were considered for these alternatives. Important considerations for formulation of alternatives were:

- Any alternative configuration that has been studied before by DW Properties, DWR, Reclamation and CALFED was included.
- Fatal-flaw reasons were used to eliminate these islands as reservoir islands for further studies:
    - MacDonald Island: non-mitigable due to Pacific Gas and Electric (PG&E) unique sub-surface gas storage
    - Upper Jones and Lower Jones Tracts: large areas of prime agricultural land
    - Woodward Island: not enough storage capacity
    - Sherman and Twitchell Islands: The Biological Opinions do not allow in-Delta storage diversions that create reverse flow conditions and increase intrusion of salinity into upstream Delta islands. Also, existing infrastructure (major transportation system and gas utilities) and environmental sensitivity make these islands cost prohibitive for storage.
    - Islands that may provide direct connection to SWP and CVP Systems such as Victoria Island were included due to potential for increased system flexibility and transfer of already screened water to Clifton Court. Also, Victoria Island does not have deep peat soils and potential for water quality problems.

Table 1
PERTINENT FEATURES OF IN-DELTA RESERVOIR STORAGE OPTIONS

No.	Storage Option	Name of Reservoir Island	Size (Acres)	Levee (Miles)	Max. Water Surface Elevation (+ feet msl)	Approx. Storage Capacity (Ac-ft)
1.	Delta Wetlands Project (216 TAF)	Bacon Island	5,450	14.3	4.0	114,965
		Webb Tract	5,374	12.9	4.0	100,664
2.	Victoria with Clifton Court Connection	Bacon Island Victoria Island (223 TAF)	5,450 7,102	14.3 15.0	4.0 4.0	114,965 107,978
		Webb Tract Victoria Island (209 TAF)	5,374 7,102	12.9 15.0	4.0 4.0	100,664 107,978

Chapter 3
OPERATION STUDIES

3.1 General

In-Delta storage will help meet CALFED's goals of increased environmental flows, improved water quality, water supply and facilitating water transfer and conjunctive use programs. Operation studies assessed potential project capability to supply additional water for environmental, agricultural and urban uses and also increase operational flexibility of the CVP and the SWP. A comparison of CALSIM-II Model results between the base and with project was used to assess the effect of in-Delta storage on water supplies, hydrodynamics of the Delta channels, Delta water quality and the operation of reservoirs north and south of the Delta. The CALSIM-II Model was used to conduct operation studies to assess the operational flexibility and water supply benefits of the project. The hydrodynamics and water quality impacts of in-Delta storage were assessed later by using the results of these operation studies as input to the DWR Delta Simulation Model (DWR DSM2). In CALSIM-II modeling studies, the modeled conditions in a particular year will not conform to the historic observed conditions for the same year. The purpose of the model is not to recreate historic conditions but to predict potential conditions under various system, regulatory and water demand scenarios. In-Delta storage operations were integrated with upstream operations. Although major impacts can occur south of the Delta or in the Delta, upstream areas can be affected through changes in carryover storage. For example, with new storage in the Delta, upstream reservoirs may hold back more water in certain years and end-of-the-period storage in Lake Shasta and Lake Oroville may be higher.

The description of operational flexibility benefits is based primarily on CALFED experience with "gaming" evaluations for the EWA. Since these benefits are difficult to quantify with existing studies, the description is based primarily on subjective judgments and observations. Impacts are evaluated in qualitative and quantitative terms. Impacts on project yield due to coordinated operations with groundwater conjunctive use, water transfers, water use efficiency and recycling are explained qualitatively. Because of limited ability to forecast population growth, land use changes and limited knowledge of the water user decision to implement other water management options, some degree of uncertainty should be attached to this evaluation.

The new CALSIM-II model was developed for daily operations in the Delta. Results of modeling studies are presented in this section. Details of these studies are presented in a separate report titled "In-Delta Storage Program Draft Report on Operation Studies," May 2002.

3.2 Operations Criteria

Operations were based on existing regulations in effect and any expected future changes such as SWRCB Decision 1643, CUWA WQMP, fisheries agencies biological opinions, CVPIA and EWA requirements. Modeled existing conditions were defined as the current level of development and current water demands. In recent studies this level is based on the 1995-level of development and it is assumed that the 2001 level of development is essentially the same. The operational requirements are assumed to meet 1995 SWRCB Water Quality Control Plan and allow Delta exports within the export/inflow ratio and the permitted pumping capacity. The recent SWRCB decision 1641 allowed south of Delta use of Tracy and Banks Pumping Plants for joint point diversions to the Central Valley and the State Water Projects under certain conditions.

A 2020 level of demand was assumed for the project. In addition to the SWRCB Water Quality Control Plan (Decision 1641), the operation criteria of in-Delta storage have been set forth in Decision 1643 adopted by the SWRCB. This decision conditionally approves the water right applications and petitions needed to appropriate water by direct diversion and storage to reservoirs on Webb Tract and on Bacon

Island. The DW Properties signed the WQMP with CUWA and its implementation is included in the operation criteria.

On May 6, 1997, the USFWS issued its final biological opinion and conference opinion concerning the effects of the Project on delta smelt and Sacramento splittail. On May 7, 1997, the NMFS issued its final biological opinion concerning the effects of the Project on the winter-run chinook salmon and steelhead. On June 19, 2001, DFG issued the California Endangered Species Act (CESA) Incidental Take Permit for the DW Project. The Incidental Take Permit and the biological opinions were incorporated in the Operation Criteria (OC) shown in Figure 5.

Figure 5: OPERATION CRITERIA

CRITERIA	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FLOW STANDARDS												
* DIVERSION TO STORAGE [1]												
D1643 Diversion Criteria												
No Diversion to Storage												
Initial Delay Period-X2 days past Chipps (75km)		10 days								10 days		
Initial Ramping Period -5,500 cfs max		5 days								5 days		
Min 14-day running avg of X2 requirement				X2 < 75 km								
Min 14-day running avg of X2 requirement	X2 < 81 km						X2 < 81 km					
Min 14-day running avg of X2 requirement when delta smelt are present at CCWD intake.												X2 < 81 km
Proj. Div is 500 cfs if 14-day running avg of X2		81 <X2 >80 km							81 <X2 >80 km			
Project Div is 1,000 cfs if 14-day running avg of X2		X2 >81 km							X2 >81 km			
Maximum allowable X2 shift (location)		2.5 km								2.5 km		
Limit on % of Net Delta Outflow	15 %	15 %	15 %	0 %	0 %	25 %	25 %	25 %	25 %	25 %	25 %	25 %
Max. Annual Diversion to Storage					Webb Tract -262 taf/year, Bacon Island - 258 taf/year							
Biological Opinion Diversion Criteria												
Initial Diversion for Water Year		X2 < 74 km								X2 < 74 km		
Minimum X2 requirement (location)		X2 < 81 km								X2 < 81 km		
Limit on % of surplus water	90 %	75 %	50 %	0 %	0 %	50 %	75 %	90 %	90 %	90 %	90 %	90 %
Limit on % of SJR - 15 days per month	125 %	125 %	50 %									125 %
Limit Diversions during DXC Closure												
Limit Div to 550 cfs unless QWEST remains +ve												
Maximum Top-Off Diversion Rate [2]						215 cfs	270 cfs	200 cfs	100 cfs	33 cfs		
Reduce Diversion to 50% of previous days diversion rate if Delta Smelt are present												
* DISCHARGE FOR EXPORT [3]												
D1643 Discharge Criteria												
Webb Tract (max 2,000 cfs)												
Fixed prohibitions				No discharges for export								
Limit on % of available export capacity							75 %					
Bacon Island (max 4,000 cfs)												
Limit on % of SJR inflow				50 %	50 %	50 %						
Limit on % of available export capacity		75 %	50 %	50 %	50 %	50 %	75 %					
Max. Chloride conc. Increase at CCWD intake							10 mg/l 14-day running average					
Zero salinity increase if it is already exceeding 90% of standard.												
Max. Annual Release of Stored Water							822 taf / year					
Max. Annual Export of Stored Water							250 taf / year					
Biological Opinion Discharge Criteria												
Reserved Environmental Water [4]	10 %	10 %	10 %	10 %	10 %	10 %						10 %
Limit Discharge for export to 50% of previous days diversion if Delta Smelt are present												

Footnotes

[1] Maximum rate of diversion onto either Webb Tract or Bacon Island would be 4,500 cfs. The combined maximum daily average rate of diversion for all islands (including 200 cfs diversions to each of the habitat islands) will not exceed 9,000 cfs.

[2] Water will be diverted onto Bacon Island and Webb Tract from June through October in order to offset actual reservoir losses of water stored on those islands, referred to as topping-off reservoirs. The maximum topping-off diversion rates shall be reduced by an amount equal to the habitat island diversions during the same period.

[3] Discharges will be pumped at a combined maximum daily average rate of 6,000 cfs. Discharge is subjected to export limits, treated as an export in the monthly E/I ratio computation except when water is discharged for environmental water account.

[4] A quantity of "environmental water" will be provided for release as additional Delta outflow equal to 10% of all discharges for export that occur in the period of December thru June.

3.3 Potential Uses

New surface storage is essential to meet CALFED's goals of increased environmental flows, improved water quality, water supply and facilitating water transfer and conjunctive use programs. In-Delta storage will increase water supplies, particularly in summer and dry periods, to meet existing shortages and accomplish these goals. It will also increase flood control protection, provide groundwater recharge and recreational benefits not afforded by classic demand management recommendations.

3.3.1 Improvement in System Operational Flexibility

In-Delta storage will provide CVP/SWP operational flexibility by providing water storage space in the Delta to capture wet and operational spills from upstream and surplus Delta outflow. This space could be used for banking North-South water transfers, conjunctive use with groundwater, CVPIA (b)(2) and Environmental Water (EW).

3.3.1.1 Environmental Flow Re-operations for Fisheries

In-Delta storage would provide flexibility in the environmental operations of the CVP and SWP. Environmental flow releases from upstream reservoirs can be captured and re-operated to maintain fisheries water quality objectives or provide environmental water to support both resident and anadromous fisheries in the Delta at the request of the fisheries agencies.

3.3.1.2 System Water Recycling Operations

This Project would provide downstream storage for operational and wet weather spills from upstream reservoirs. This project would add flexibility to the operation of upstream reservoirs because the fear of losing the water to the ocean would be reduced. Water released from upstream reservoirs for in-stream flow requirements in the Sacramento, American and San Joaquin Rivers can be reused through operations.

3.3.1.3 Delta Outflow and Water Quality Requirements

In-Delta storage water could be used to meet Delta flow and water quality objectives more quickly than upstream reservoirs, providing greater operational flexibility. This water would be used to meet outflow needs on an emergency basis or to fine-tune operations in the Delta.

3.3.1.4 CVP/SWP Operations

Additional system storage would allow fine-tuning of CVP/SWP operations. Water stored in the project could be used just like other sources of stored water to meet export demands or Delta outflow requirements.

3.3.1.5 Water Transfers

An in-Delta storage project could provide available storage capacity to buyers and sellers to transfer water from north to south. This project could assist in better timing of transfers.

3.3.1.6 Joint Point of Diversion

A joint CVP/SWP facility would significantly increase the use of the project water. Banks Pumping Plant wheels water for the CVP and EWA when there is excess capacity at Banks. An in-Delta storage project will provide a function similar to the current EWA storage account in San Luis Reservoir.

3.3.1.7 Conjunctive Use Program

Flows captured in the in-Delta storage could benefit conjunctive use programs. In-Delta storage could be a key element in this program, either by providing surface water to a groundwater extractor, thereby facilitating in lieu recharge, or by providing surface water for artificial recharge of a groundwater basin.

3.3.1.8 CVPIA (b)(2)

The CVP dedicates 800 TAF per year from project yield to fish and wildlife restoration under CVPIA Section 3406 (b)(2). The water allocated to (b)(2) is equivalent to a new water demand on the CVP system.

3.3.1.9 Refuge Water Supply

CVPIA requires firm Level 2 water supplies to national wildlife refuges to equal annual historical water deliveries (Level 2). Additional water is to be provided for optimal wildlife management (Level 4) within 10 years of enhancement. An in-Delta storage project could help meet Level 2 and Level 4 refuge demands that would otherwise be met through existing storage.

3.3.1.10 Municipal and Industrial (M&I) and Agricultural Demand

In-Delta storage will meet the M&I and agricultural demand when pumping capacity exists at the Tracy and Banks Pumping Plants. This water could be used directly to meet CVP and SWP demands or could be temporarily stored in San Luis Reservoir.

3.3.1.11 EWA

The EWA largely relies on water transfers from Northern California to fund the account during the initial years. Due to limited upstream opportunities in the Sacramento Valley for CALFED and its agencies to purchase or otherwise develop water assets, in-Delta storage can provide space for EWA.

3.3.2 Supply Reliability

Water supply reliability is improving the predictability and availability of economic benefits derived from water while restoring ecosystem health in the Bay-Delta estuary and watershed. Many urban water managers worry about California’s water supply reliability during an extended drought. In-Delta storage would help improve water supply reliability for urban and agricultural water users and the environment during dry years.

3.3.3 Water Marketing

Water marketing – the sale, exchange, or lease of water from one user to another – has the potential for becoming a key tool for meeting rising water demand. Water marketing is a tool for addressing statewide imbalances between water supply and water use. Water marketing can be used for statewide water supply augmentation option. It allows water agencies to purchase additional water supply reliability during both average and drought years. In-Delta storage can help by providing surface storage for exchange, sale or lease among users.

3.4 Operations Modeling

3.4.1 CALSIM-II Model Development

CALSIM-II is a general-purpose Water Resource Systems Model, developed by DWR and Reclamation to simulate operation of the CVP and the SWP System of reservoirs and conveyances. CALSIM-II uses optimization techniques to efficiently allocate water through a network of nodes and arcs, given user-defined priority weights. A mixed integer linear programming (MILP) solver determines an optimal set of decisions for each time period given a set of weights and system constraints. WRESL statements describe the physical system (dams, reservoirs, channels, pumping plants, etc.), operational rules (flood-control diagrams, minimum in-stream flows, delivery requirements, etc.), and priorities for allocating water.

Because standards imposed by SWRCB and other regulations are daily standard, modeling of in-Delta storage operations required a model with a daily time-step for defining the diversion and release rules. A daily time-step Delta Model was developed for conducting in-Delta storage studies. This model was used in conjunction with the CALSIM-II monthly model for North and South of Delta operations.

Artificial Neural Network (ANN) routine has been developed and implemented in CALSIM-II to correlate DSM2 model-generated salinity at key locations in the Delta to Delta exports, Delta Cross Channel operations, and major Delta inflows. The ANN flow-salinity module predicts electrical conductivity at the following three locations: Old River at Rock Slough, San Joaquin River at Jersey Point, and Sacramento River at Emmaton.

3.4.2 CALSIM-II Model Application

The entire system's operation was simulated for one month period with the CALSIM-II monthly model and then the information on inflows to the Delta and the south-of Delta delivery amounts was passed on to the Daily Delta Model. The Daily Delta Model then re-simulated the operations in the Delta, and the export facilities.

The monthly averaged inflows to the Delta from the monthly model were converted into daily hydrographs. For this purpose, a utility program developed to pattern these monthly averaged Delta inflows after the historically recorded flows. Historic flows of the Sacramento River at Freeport, the San Joaquin river at Vernalis, a combination of the Mokelumne River at Woodbridge and the Cosumnes River at Sloughhouse, and a combination of flows at the gage near Woodland, the Sacramento Weir near Bryte, and the Putah Creek near Davis were analyzed.

After the daily operation was done, the results of the Daily Delta Model were provided to the monthly model as the initial conditions for the following month's simulation. The operation of the upstream reservoirs was not re-simulated, and any gains or losses of water were reflected in the Delta outflow and the storage at San Luis Reservoir. The next month's simulation was then started with the modified end-of-month storage in San Luis Reservoir and the state of the Delta as simulated by the Daily Delta Model.

To achieve the most efficient operation of the two water supply storage facilities in the with-project simulation run, the priority of filling was given to Bacon Island. This was done because the more extended period of allowable discharge from Bacon Island allowed for potential withdrawal and subsequent filling in the same year more readily, whereas the limited allowable period for discharge from Webb Tract made multiple filling in the same year practically impossible. The priority of filling in Bacon Island was achieved by assigning a higher reward for diverting the available water into the conservation storage of Bacon Island as compared to that of Webb Tract.

3.5 Water Supply Operation Studies

The following modeling studies were conducted to evaluate in-Delta Storage operations.

- Base Case Operations
- Webb and Bacon Reservoirs in-Delta storage Operations without water quality constraints for maximum diversions of 6,000 cfs
- Victoria and Webb Reservoirs with 6,000 cfs maximum diversion and Victoria connection to Clifton Court with 2,000 cfs maximum release capacity
- Operations with delta smelt, 1997 USFWS Fall Mid-Water Trawl (FMWT) Index Constraints
- Operations with DOC Constraints
- Impact of Climate Change

Operation criteria stated in Section 3.2 were used in these studies. Detailed information on modeling assumptions used in these studies is presented in the "Draft Report on Operation Studies," May 2002. A brief description and results of these studies are summarized in the following section.

3.5.1 Base Case Operations

For computing project yield, the base case above which the new project would supply additional water is important. Two main considerations for selection of this base case were hydrology and water demands. It was assumed that the system would be operated according to SWRCB's Water Rights Decision 1641, and 2020 Level of Hydrology and Demands. A 2020 level no action condition was defined to represent a reasonable uncertainty in the pre-implementation condition. Although a land use change is expected from the present to the 2020 level planning horizon, hydrological studies indicate that future 2020 level hydrology based water supply may not show appreciable change. With the increase in population, water demands are expected to change. These demands include a total annual SWP demand that varies between 3.6 MAF and 4.2 MAF. The maximum interruptible demand is 134 TAF per month. The total annual CVP demand is 3.5 MAF. This includes the annual Level II Refuge demand of 288 TAF. Cross Valley Canal demand is 128 TAF/year. Banks Pumping Plant export capacity of 10,300 cfs was used. Trinity River Minimum Fish flows below Lewiston Dam are maintained at 340 TAF/year.

Results of the Base Case modeling study are given in Table 2. Further details are presented in the "Draft Report on Operation Studies," May 2002.

3.5.2 In-Delta Storage Operations Without Delta Smelt and DOC Constraints

Two operation studies were conducted with in-Delta storage operations as presented in Table 2. The first study simulated the original DW operations for the 1922 to 1994 historical period with Webb Tract and Bacon Islands as reservoirs by assuming maximum diversion of 6,000 cfs. The daily CALSIM-II Model for the Delta was used. This study was performed by incorporating all the criteria stated in the SWRCB Decision 1643, WQMP salinity constraints and fisheries Biological Opinion constraints. Exceptions to this were the USFWS FMWT condition of less than 239, representing the abundance of delta smelt, and DOC WQMP constraints not used in the original DW Project operations. The common assumptions applied to the Base Case were also applied to this study. Details of modeling assumptions are given in the "Draft Report on Operation Studies," May 2002.

As in the Base Case, 2020 Level of Hydrology and Demands were used for in-Delta storage operations. The daily CALSIM-II model configuration included DW Webb Tract and Bacon Island reservoirs. The permitted diversions to Holland and Bouldin habitat islands were included in the modeling.

As presented in Table 2, the total average annual Delta export of 126 TAF is possible even if the diversion to reservoir islands is reduced from the maximum permitted 9,000 cfs diversion to 6,000 cfs.

Average annual surplus water diverted to DW reservoirs during the dry period was 49 TAF and during the 73 years was 134 TAF. During the dry period from May 1928 to October 1934, 11 TAF additional delivery than what was diverted into the reservoirs was made. This is the additional benefit of storage reservoirs from the stored water in previous wet years. The FOC of the biological opinion also included a constraint for mandatory release of 10% of the exported water termed as Environmental Water. At present, daily CALSIM-II model does not have the capability for EW and CVPIA evaluation and further development work is needed.

A second operation study was conducted for the Victoria Island direct connection to Clifton Court. As shown in Table 2, average annual export is 122 TAF.

Table 2
OPERATION STUDIES RESULTS
(All units in TAF)

Studies	SWP/CVP Contract Deliveries		SWP Interrruptible Deliveries		SWP/CVP Deliveries with Interrputibles		Total Delta Exports (SWP+CVP)		Total Delta Inflow		Minimum Required Delta Outflow		Delta Surplus		Total Delta Outflow	
	Dry Period Avg	73-Yrs Avg	Dry Period Avg	73-Yrs Avg	Dry Period Avg	73-Yrs Avg	Dry Period Avg	73-Yrs Avg	Dry Period Avg	73-Yrs Avg	Dry Period Avg	73-Yrs Avg	Dry Period Avg	73-Yrs Avg	Dry Period Avg	73-Yrs Avg
Base Study 1	3,503	5,468	35	151	3,538	5,619	3,646	6,030	10,190	21,017	3,004	2,390	2,420	11,714	5,424	14,104
In-Delta Storage Study (Webb Tract & Bacon Island as Storage Reservoirs with 6000 cfs maximum diversion to Storage)	3,580	5,577	36	168	3,616	5,745	3,726	6,156	10,210	21,018	3,032	2,394	2,364	11,573	5,396	13,967
Difference (In-Delta storage Study -minus- Base Study)	77	109	1	17	78	126	80	126	20	1	28	4	-56	-141	-28	-137
In-Delta Storage Study (Webb Tract & Victoria Island as Storage Reservoirs with 6000 cfs maximum diversion to Storage)	3,516	5,570	49	172	3,565	5,742	3,682	6,155	10,201	21,017	3,007	2,393	2,409	11,577	5,416	13,970
Difference (In-Delta storage Study -minus- Base Study)	13	102	14	21	27	123	36	125	11	0	3	3	-11	-137	-8	-134

3.5.3 In-Delta Storage Operations with Delta Smelt Constraint

The 1997 FOC of the USFWS has constraints for FMWT of less than or higher than 239. This index is developed for each year based on delta smelt abundance during the months from September to December. These restrictions apply if the index shows a significant decline in delta smelt abundance. This criterion was not applied in the original DW study. Monthly restrictions on diversions are stated in the FOC based on FMWT. No diversions can be made from February 15 to the end of June if FMWT is less than 239. FMWT Index data is available from 1967 to 1994. Data indicates there are 8 years during this period when the FMWT index is lower than 239. The criteria provide for a higher partial value of FMWT if it is available before its final calculation in December.

Results of this study as compared to in-Delta operations for the same period without FMWT <239 constraint are given in Table 3 and show a reduction of 20 TAF in the exports. As these results are based on a partial time period out of 73 years historical period, a probability analysis should be conducted to define complete impact of this reduction over a 73-year period. There is a need for further discussions on the fisheries criteria application in light of DW Project being included as a CALFED project.

3.5.4 In-Delta Storage Operations with DOC Constraints

WQMP criteria limit releases from in-Delta reservoirs if the DOC value at the urban intakes exceeds 4 mg/l. As given in Water Quality Investigations Chapter 4, DOC values ranges were predicted through water quality studies. For CALSIM-II modeling studies, two Asymptote (A) DOC values were used: 70 mg/l and 215 mg/l. These values represent DOC at the two feet reservoir levels and depending on the depth of the reservoir, DOC can change. For example with higher depth than two feet, DOC value will decrease. Roughly a 20 feet depth reservoir will represent a low bookend DOC value of 6.76 mg/l for Asymptote equal to 70 mg/l. Similarly, a 20 feet depth reservoir will represent a high bookend DOC value of 20.77 mg/l for a 215 mg/l Asymptote value. Two CALSIM-II modeling studies, one with low bookend DOC and another with high bookend DOC value were performed to assess the impact of DOC restrictions on releases from the in-Delta storage project. Results of the DW Study without DOC constraints were used as input to the DSM2 model to determine WQMP DOC constraint compliance at the urban intakes. Details of DSM2 water quality modeling are given in Chapter 4. The water quality modeling showed DOC standards were exceeded at the urban intakes. In order to comply with the WQMP criteria, the CALSIM-II model was modified to include additional water quality rules for releases from the Webb Tract and Bacon Island reservoirs.

These preliminary studies were conducted for a period from 1975 to 1991 as the source water DOC information was available only for this period. As shown in Table 3, DOC constraints reduce annual average delivery to urban intakes by 16 TAF for the high bookend DOC value. There is no reduction in the average annual delivery for the low bookend DOC value.

The CALSIM-II modeling studies conducted for the study do not have allocation of water supplies or storage between SWP, CVP, environmental, CVPIA, water banking and transfers. Re-operation with proper allocations may show additional CVPIA and EWA benefits.

Table 3
IMPACT OF DELTA SMELT (FMWT<239) AND DOC WQ CONSTRAINTS ON WATER SUPPLIES

CALSIM-II Study (Study Period 1975- 1991)	Total SWP/CVP Average Annual Delivery (TAF)	Difference in Average Annual Delivery from Base (TAF)
In-Delta Storage Study without Delta Smelt (FMWT <239) and DOC Constraints	103	--
In-Delta Storage Operation with Delta Smelt (FMWT <239)	83	20
In-Delta Storage Operation with Low Bookend DOC (Asymptote DOC value = 70mg/L)	103	0
In-Delta Storage Operation with High Bookend DOC (Asymptote DOC value = 215 mg/L)	87	16

3.5.5 Climate Change Impact Study

Due to potential climate change, it is possible that runoff patterns may change. More rain in winter months may result in loss of snow cover and increased flooding. Due to less snow cover than normal, winter flows may be higher and late spring flows may be lower than presently assumed in operation studies. This can cause a shift in hydrological inflows to the Delta. The DWR Flood Management Division made an assessment of flow variations as a result of climate change. A preliminary monthly hydrology was developed with altered patterns of reservoir inflows in the upper San Joaquin River and the Sacramento

River watersheds. This study is more of a sensitivity analysis and results should be considered as preliminary.

Monthly inflows to reservoirs were used for CALSIM-II monthly model run. Monthly output from this run was converted into daily flows for the base case model run without an in-Delta configuration. A second study was conducted using potential flows due to climate change with the in-Delta storage project. Both studies were performed for the 1922 to 1969 period. Results in Table 4 indicate a storage project in the Delta will capture early winter flows and the yield will increase as a result of change in flow patterns due to climate change. Results also indicate Lake Oroville storage is higher in dry periods. Operations may be revised and may result in increased in-Delta storage project yield.

Table 4
PRELIMINARY ASSESSMENT OF CLIMATE CHANGE IMPACT ON IN-DELTA STORAGE OPERATIONS

Item	In-Delta Storage Operations Study without Climate Change Impact on Flows (TAF)	In-Delta Storage Operations Study with Climate Change Impact on Flows (TAF)	Net Impact due to Change in Flow Patterns (1922-1969) (TAF)
Delta Surplus	10,666	10,680	+14
In-Delta Storage Diversions:			
Webb Tract	54	60	
Bacon Island	76	75	
	130	135	+5
In-Delta Storage Releases:			
Webb Tract	50	55	
Bacon Island	71	69	
	121	124	+3

3.6 Summary of Findings

Operational modeling studies conducted using the SWRCB, WQMP, and DFG and USFWS criteria indicate:

- Based on the 73-year historical period daily modeling, the average annual yield of the In-Delta Storage Project is 126 TAF/year without reductions in yield required to fully comply with the delta smelt and WQMP criteria.
- Based on the 1975 to 1991 period modeling study, USFWS 1997 FOC for decline in delta smelt abundance reduces average annual yield by 20 TAF.
- To comply with the WQMP DOC requirement, a preliminary CALSIM-II study indicates a reduction of 16 TAF in yield with the high DOC bookend value. With project re-operations with allocations between SWP, CVP, environmental, CVPIA, water banking and transfers, impact on the yield may be reduced.
- Preliminary climate change studies indicate in-Delta storage can be effective in capturing early winter flows due to change in flow patterns as a result of climate change.

3.7 Recommendations

- Further evaluations are needed to allocate water supply benefits between south of Delta exports, EWA, CVPIA, water banking and transfers. Daily CALSIM-II modeling should continue for quantitative determination of project water use for environmental, CVPIA and other purposes in addition to South of Delta exports.
- There is a need to hold further discussions on the fisheries criteria application in light of DW Project being included as a CALFED project.

Chapter 4
WATER QUALITY EVALUATIONS

4.1 General

The current water quality standards in the Delta are based on the SWRCB Decision 1641. With SWRCB Decision 1643, additional requirements were imposed for the DW Project. In this section, information is presented on water quality field and modeling investigations undertaken to determine the water quality implications of DW proposal.

Four water quality studies were conducted to assess the potential water quality impacts of operating the DW Project. Those four studies were based on the water quality requirements listed below and included: 1) modeling studies, 2) field investigations, 3) biological productivity studies and 4) temperature and DO studies. Results of these four water quality investigations are summarized in the following chapter. More detailed information is provided in a separate report titled, "In-Delta Storage Program, Draft Report on Water Quality Investigations," May 2002.

4.2 Water Quality Requirements

There are several water quality requirements set forth in the SWRCB Decision 1643 and the WQMP to ensure that the DW Project will not create significant water quality impacts.

4.2.1 General Requirements

Discharge of water from the DW Project shall not cause: (1) any applicable water quality objective in a water quality control plan adopted by the SWRCB or by the RWQCB to be exceeded; (2) any recipient water treatment plant to exceed the maximum contaminant levels for disinfection by-products as set forth by EPA in Title 40, Section 141.12 & 141.30. The regulated classes of disinfection by-products are trihalomethanes, haloacetic acids, chlorite, and bromate (SWRCB, condition 14.a.). An uncertainty of ± 5% of the screening criteria will be assumed in order to determine if the DW Project has met one or more of the operational screen criteria.

4.2.2 Specific Requirements

There are also many specific water quality requirements that include criteria for TOC, chloride, disinfection byproducts (DBPs), DO and temperature. Specific criteria are briefly described below. For a more detailed description, see the Water Quality report.

> **TOC:** The project shall not cause the TOC concentrations at a SWP, CVP, or CCWD pumping plant to exceed a limit of 4.0 mg/L (14-day average), or cause an incremental increase in TOC concentration greater than 1.0 mg/L. In addition, discharges from Bacon Island and Webb Tract are limited based on the concentration of TOC in the reservoir water at the time of discharge. See the Water Quality Report for a more detailed description of TOC criteria.
>
> **Chloride:** The project operation shall not cause an increase in chloride concentrations of more than 10 mg/L at any of CCWD's intakes or cause any increase in salinity of more than 10 mg/L chloride (14-day running average salinity) at any urban intake in the Delta. The project shall not cause or contribute to any salinity increase in an urban intake if the intake is exceeding 90% of the Rock Slough chlorine standard as defined in SWRCB Decision 1641. In addition, discharges from the reservoir islands are limited based on the concentration of chloride in the reservoir water. See the Water Quality Report for a more detailed description of chloride criteria.
>
> **DBPs:** DW Project operations will be curtailed, rescheduled, or constrained to prevent impacts on drinking water quality if project operations cause or contribute to 1) modeled or predicted total

trihalomethanes (TTHM) concentrations in drinking water in excess of 64 µg/L, as calculated in the raw water of an urban intake in the Delta or at the outlet of a water treatment plant or 2) modeled or predicted bromate concentrations in drinking water in excess of 8 µg/L, as calculated in the raw water of an urban intake in the Delta or at the outlet of a water treatment plant.

DO: Discharge of stored water is prohibited if the DO of stored water is less than 6.0 mg/L, if discharges cause the level of DO in the adjacent Delta channel to be depressed to less than 5.0 mg/L, or if discharges depresses the DO in the San Joaquin River between Turner Cut and Stockton to less than 6.0 mg/L September through November.

Temperature: Discharge of stored water is also prohibited if the temperature differential between the discharge water and receiving water is greater than 20º F, or if discharges will cause an increase in the temperature of channel water by more than: 4º F when the temperature of channel water ranges from 55º F to 66º F, 2º F when the temperature of channel water ranges from 66º F to 77º F, or 1º F when the temperature of channel water is 77º F or higher.

4.3 Water Quality Investigations

Information on the four water quality investigations: modeling studies, field investigations, biological productivity, and temperature and DO studies is presented in the following sections.

4.3.1 Modeling Studies

Two model scenarios were evaluated as part of the in-Delta Storage water quality evaluation. The first scenario is a “base case” without in-Delta Storage Program facilities using the SWRCB Decision 1641 operational requirements. The second scenario represents the in-Delta Storage Program operations including the SWRCB Decisions 1641 and 1643. Both model scenarios assume daily varying Delta hydrology and operations as provided by CALSIM-II model simulations. The water quality modeling studies were conducted with the Department’s Delta Simulation Model (DSM2). CALSIM-II, a water accounting model, is not designed to simulate water quality transport processes. It uses flow-salinity relationships and operating rules to determine if water quality standards are being met by a particular planning scenario. DSM2, on the other hand, is designed to simulate water quality transport processes. These two models are not dynamically linked. Instead, DSM2 is run using output generated by CALSIM-II. Because of this, DSM2 may show water quality constraints being violated by a particular CALSIM-II operation. DSM2 was calibrated and validated for flow, stage and electrical conductivity (EC) in collaboration with the DSM2 Interagency Ecological Program Project Work Team. The model was also successfully validated for the transport of DOC. DSM2 simulations covered the 16-year period October 1, 1975, through September 30, 1991. For boundary conditions, time series of Delta inflow DOC concentrations were developed from available flow and water quality grab sample data. Delta inflow DOC boundary conditions for the 16-year simulation period are shown in Figure 6.

Under the proposed operations due to restrictions on releases, higher DOC water (shown in Figure 6) in spring is stored in DW reservoirs and is released in summer months. However, DOC concentrations in Delta channels reduce during summer with fresh inflows from upper reservoirs. Thus high DOC in the DW reservoirs water could result in reduced releases and lower yield. Restrictions on releases need to be reviewed with regulatory agencies for improved operations. Findings and recommendations of the modeling studies are presented in detail in “In-Delta Storage Program, Draft Report on Water Quality Investigations,” May 2002.

Tables 5a through 5f show times when modeled DOC and other water quality impacts exceed criteria given in the WQMP.

Figure 6a: DELTA INFLOW DOC BOUNDARY CONDITIONS

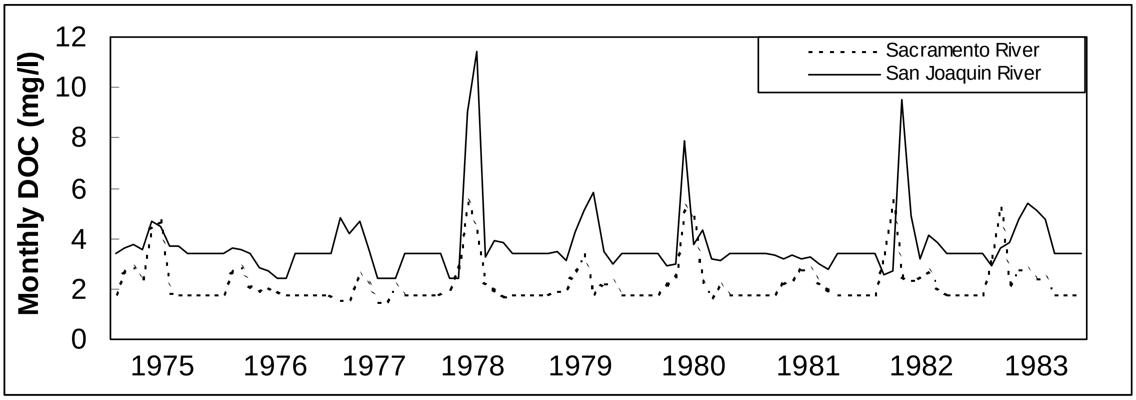


Figure 6b: DELTA INFLOW DOC BOUNDARY CONDITIONS

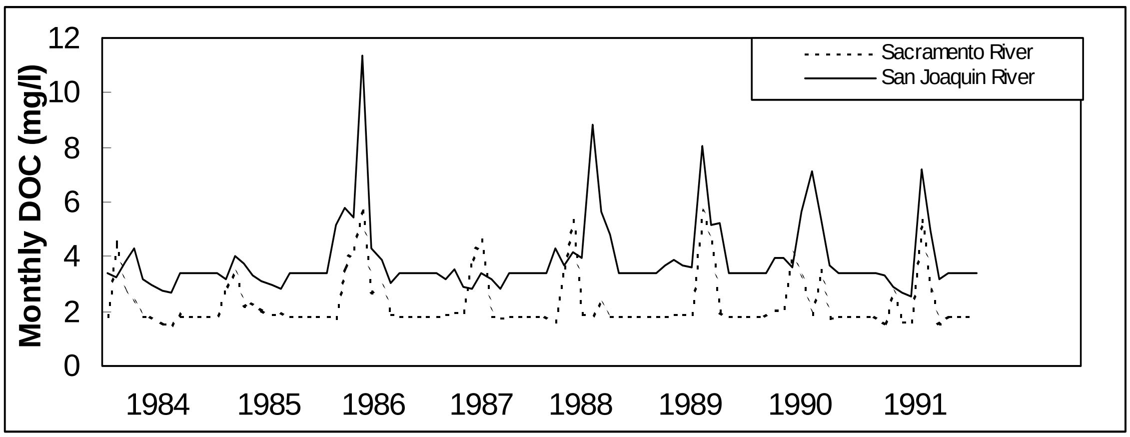


Table 5a. FREQUENCY OF DOC CONSTRAINT EXCEEDANCE

Location	**Low Bookend (# months in 16 yrs)**	**Low Bookend (% months in 16 yrs)**	**High Bookend (# months in 16 yrs)**	**High Bookend (% months in 16 yrs)**
Old River at Rock Slough	0	0	6	3
Old River at Los Vaqueros Intake	1	1	6	3
Banks Pumping Plant	4	2	7	4
Tracy Pumping Plant	4	2	7	4

Table 5b. FREQUENCY OF TTHM CONSTRAINT EXCEEDANCE

Location	Low Bookend (# months in 16 yrs)	Low Bookend (% months in 16 yrs)	High Bookend (# months in 16 yrs)	High Bookend (% months in 16 yrs)
Old River at Rock Slough	0	0	0	0
Old River at Los Vaqueros Intake	0	0	0	0
Banks Pumping Plant	0	0	1	1
Tracy Pumping Plant	0	0	0	0

Table 5c. FREQUENCY OF BROMATE CONSTRAINT EXCEEDANCE

Location	Low Bookend (# months in 16 yrs)	Low Bookend (% months in 16 yrs)	High Bookend (# months in 16 yrs)	High Bookend (% months in 16 yrs)
Old River at Rock Slough	1	1	1	1
Old River at Los Vaqueros Intake	1	1	1	1
Banks Pumping Plant	2	1	2	1
Tracy Pumping Plant	2	1	2	1

Table 5d. FREQUENCY OF CHLORIDE CONSTRAINT EXCEEDANCE

Location	# months in 16 years	% months in 16 years
Old River at Rock Slough	11	6
Old River at Los Vaqueros Intake	10	5
Banks Pumping Plant	7	4
Tracy Pumping Plant	7	4

Exceedance of the 10 mg/l chloride screening criterion generally occurred in fall months when there were no major releases from or diversions to the project reservoir islands. Therefore, chloride violations were not directly related to Project releases or diversions but appear to result from CALSIM-II re-operation of the CVP/SWP system. Model results showed that the Project improved chloride concentrations at Banks Pumping Plant about 60 percent of the time.

Table 5e. FREQUENCY OF LONG-TERM DOC CONSTRAINT EXCEEDANCE

Location	Low Bookend (# months in 13 yrs)	Low Bookend (% months in 13 yrs)	High Bookend (# months in 13 yrs)	High Bookend (% months in 13 yrs)
Old River at Rock Slough	0	0	12	8
Old River at Los Vaqueros Intake	n/a	n/a	n/a	n/a
Banks Pumping Plant	0	0	78	50
Tracy Pumping Plant	0	0	39	25

Table 5f. FREQUENCY OF LONG-TERM CHLORIDE CONSTRAINT EXCEEDANCE

Location	# months in 13 years	% months in 13 years
Old River at Rock Slough	14	9
Old River at Los Vaqueros Intake	n/a	n/a
Banks Pumping Plant	8	5
Tracy Pumping Plant	0	0

Change in channel stages in the Delta as a result of the DW Project is also a concern raised by the South Delta Water Agency. Difference in Middle River (South of Mokelumne Aqueduct) stage differences between the Base Case and the DSM2 Run for 6,000 cfs diversion are shown in Figure 7. Differences indicate maximum variation of 0.25 feet. In the current state, river stages variations of 0.5 feet or larger are common due to tidal and diversion operations. This analysis shows that the DW Project does not interfere with the South Delta barriers operation. The change in stage is small and it will not impact south Delta farming diversions, regardless if barriers are in operation or not.

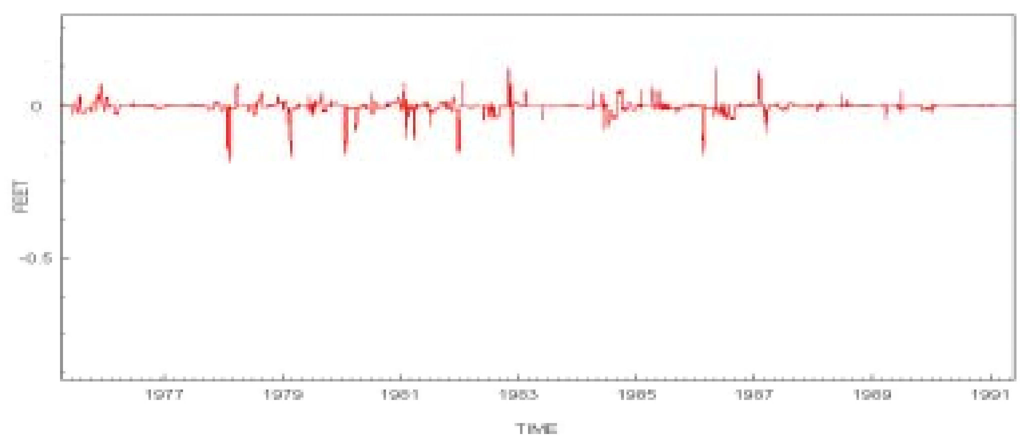


Figure 7: STAGE VARIATIONS IN MIDDLE RIVER SOUTH OF MOKELUMNE AQUEDUCT DUE TO PROJECT

The key findings of the modeling studies are as follows.

- DSM2 Model runs show exceedance of WQMP, DOC criteria at urban intakes.
- DOC and disinfection by-product impacts could be higher than reported in the model simulations, as the simulations did not account for reservoir biological productivity.
- Additional impacts could occur due to other water quality criteria, especially temperature and DO criteria.
- Compliance with the WQMP and SWRCB criteria would reduce water quality impacts to acceptable levels at the cost of reduced project water supply.
- Project re-operations could likely reduce water quality impacts and increase supply.

The following recommendations are based on the findings and conclusions of the modeling studies:

- Additional studies are needed to quantify the reduction in supply associated with meeting water quality criteria
- Additional studies are also required to determine how re-operation of the project might avoid or minimize water quality impacts without reducing supply
- Subsequent studies should consider reservoir biological productivity

In line with the first recommendation, DSM2 model results were used to develop preliminary CALSIM-II water quality operating rules for diversions and releases from project reservoirs. CALSIM-II results using these preliminary operating rules are discussed in Chapter 3, Section 3.5.4. The CALSIM-II results were not re-evaluated in DSM2. Additional studies are recommended to develop a more complete simulation of DOC impacts by incorporating organic carbon from seepage return flow and biological productivity.

4.3.2 Field Investigations

The field investigations included laboratory analyses, tank experiments conducted at SMARTS and a review of existing Delta water quality data and literature. The literature search confirmed that there were no deep reservoir projects on peat soils constructed or operated like the DW Project that could serve as a model or case study. Therefore, the data from the laboratory analyses and tank experiments were used in the development of a conceptual model and algorithm that predicts changes in organic carbon concentrations from the peat soils in the DW Project reservoirs. Explanatory variables included diversion water quality, storage holding time, season, water depth and soil characteristics. The conceptual model for reservoir island organic carbon model included sources and loads from three major origins: (1) peat soil, (2) seepage water return, and (3) biological production. Results and conclusions of the field investigations are presented in detail in “In-Delta Storage Program, Draft Report on Water Quality Investigations,” May 2002. The key findings of the field studies are:

- Carbon loading can be modeled using logistics equations representing flooding of islands with low and high organic peat soil and predicted concentrations at about 6 and 19 mg/L, respectively
- About half to 80% of the maximum carbon loading would be reached in 150 days and over 90% after 10 months of storage, under the DW Project winter filling schedule

The following recommendations are based on the results and conclusions of the field investigations.

- Develop laboratory methods to correlate soil characteristics with organic carbon release and possibly develop additional logistics equations for different soil types
- Update island soil survey to better understand the distribution of the organic carbon availability
- Do additional experiments to determine how alternating wet and dry periods affect microbial processes

4.3.3 Biological Productivity Studies

The biological productivity studies were based primarily on a review of the current literature. The specific tasks included: 1) identify key parameters affecting plant growth and degradation on the islands, 2) develop tractable groupings of plants that can be related to conditions on the islands and develop algorithms to describe plant growth, 3) analyze fate of organic carbon fixed on the islands during plant growth and develop algorithms to describe degradation and release of organic carbon to the Delta channels and 4) examine carryover affects from fill to fill and develop method of accounting for this in the modeling. Results of the bio-productivity analysis are presented in detail in Chapter 4 of the “Draft Report on Water Quality Investigations,” May 2002. The key findings are:

- Diversion and discharge timing are likely to be important factors that will determine what types of plant will dominate on the reservoir islands, how productive they’ll be and how much fixed carbon will end up discharged
- Phytoplankton is likely to dominate first three to five years and contribute to TOC loading by about 1 to 6.5 mg/L C. After that, submersed macrophytes will probably take over and contribute about 1 to 10 mg/L C
- Aquatic plant productivity would be highest under drained conditions and emergent plants would contribute about 5 to 50 mg/L C

The following recommendations are based on the results and conclusions of the bio-productivity studies.

- Reduce uncertainty by doing experiments that investigate the complex ecological processes that will affect both short term and long term plant growth and carbon export for the reservoir islands.
- Begin experiments similar to the SMARTS peat soil studies but with a plant and algal productivity component included this winter 2001-2002. Results form this study should then be used to develop a bioproductivity module for CALSIM similar to the one developed for peat soils. Results should also be used to determine the direction of future studies that will further reduce uncertainty.

4.3.4 Temperature and DO Studies

The temperature and DO studies were conducted to estimate temperature and DO differences between reservoir and channel waters and to evaluate the ability of the project to meet the temperature and DO criteria as described in section 4.2 above. The temperature and DO studies involved a combination of analyzing observed data and spreadsheet modeling. The analyses of observed data provided a range of temperature and DO values in the Delta and established upper and lower bounds. An island temperature and DO algorithm was developed with an Excel spreadsheet and the model was tailored to the specifications of this project. The temperature and DO algorithm is based on the fundamental components of the heat budget and DO balance. Impacts to the adjacent river were analyzed through mass balance equations. The modeling was conducted using a daily time step and using daily averaged meteorological and flow data. It was also assumed that the flooded islands would be completely mixed due to the high winds that are experienced throughout the year in the interior Delta. The years 1998-2001 were investigated for the water temperature modeling while 1998-2000 were analyzed for the DO modeling. Results of the temperature and DO studies are presented in Chapter 5 of the “Draft Report on Water Quality Investigations,” May 2002. The key findings are:

- Temperature differentials between the proposed reservoirs and Delta channels ranged from 1 to 9 °F and this may limit releases of stored water into the channels during low flow periods.

The following recommendations are based on the temperature and DO studies results.

- Additional modeling studies are needed to quantify the possible affects of temperature criteria on project yield.

Chapter 5
ENGINEERING INVESTIGATIONS

5.1 General

The Delta is a unique feature of California as its levee system has been developed over the past 150 years (with varying degrees of engineering design and construction technology). In addition, the geologic makeup of the Delta is very diverse creating an unequaled engineering challenge with respect to the proposed in-Delta storage alternatives.

The engineering design criteria and design of the embankments and fish screens, siphons and pumping stations for the DW Project as proposed were reviewed in-depth. Alternative design solutions and configurations to improve the proposed design were analyzed. These studies were conducted jointly by Reclamation and DWR. URS performed Risk Analyses to evaluate the risk of failure due to operation, seismic and flooding events. In addition, CH2M HILL conducted an evaluation of the proposed fish screens, siphons and pumping stations. Summary information on the engineering studies related to design, construction and facility costs is presented in this chapter. Details of engineering studies are given in the “Draft Report on the Engineering Investigations,” May 2002.

5.2 Data Collection

5.2.1 Hydrology

Two events of maximum river flood heights were considered for this study: flood heights resulting from a flood having an average recurrence interval of 100 years (100-year flood) and that having an average recurrence interval of 300 years (300-year flood). Based on available, published records, the 100-year flood water-level elevations within the project area vary from approximately 6.6 feet above MSL near Webb Tract to 7. 4 feet above MSL in the vicinity of Bacon Island and approximately 7.7 feet above MSL near Victoria Island. Based on the USACE information estimated 300-year flood water levels are 0.5 feet higher than the 100-Year flood level. The design crest elevation for the embankments proposed at each reservoir island was estimated using the corresponding 100-yr-flood water elevation, in conjunction with an appropriate freeboard. The 300-year flood water-level elevations were utilized to evaluate the crest elevation and construction costs of embankments that would be required to minimize the potential for overtopping due to water levels resulting from the potential rise in sea level due to climate change.

Flow and river stage information utilized for hydraulic analysis of the proposed structures was obtained from the DWR CDEC Database, and the IEP recording stations: San Joaquin River at Andrus Island (Station ID. RSAN032), Middle River at Howard Road Bridge (Station ID. MHR), Old River at Bacon Island (Station ID. BAC), Old River at Byron (Station ID. ORB), and Middle River at Tracy Boulevard (Station ID. MTB).

5.2.2 Topography

Topographic maps of Webb Tract, Bacon Island and Victoria Island were prepared from the results of aerial photography conducted in June 2001. These maps show the ground contours at 5-foot intervals, and are based on California Coordinated Zone 3, NAD 83 and vertical NAVD 88 system. In addition survey of the levee crown elevations was carried out at Webb Tract and Bacon Island by DWR’s ground survey team. These elevations were incorporated into the topographic maps for these islands.

The topographic maps were utilized for determining the storage capacities of the reservoir islands, the locations and layout of the proposed facilities and analysis and design of the facility components. Detailed earthwork quantities were developed using survey data obtained in June 2001 and the “Sacramento-San Joaquin Delta Levee Rehabilitation Study”, CALFED, September 1998 to estimate materials needed for levee cross-sections around the perimeter of the reservoir island levees. Rock riprap quantities for the slough side slope modifications were estimated from the soundings information compiled by MBK Engineers based on field surveys conducted in 1996 by Kjeldsen, Sinnock & Neudeck Inc.

5.2.3 Geotechnical Information

A search of DWR, Reclamation and USACE records for available geotechnical information related to past drillings or explorations in the vicinity of proposed structures was conducted. Also, for evaluation, analysis, and design purposes, available geotechnical information contained in previously published reports was used. Specifically, the geotechnical investigations conducted for the DW Project as presented in the Harding Lawson Associates study dated February 15, 1989, and in the URS Greiner Woodward Clyde Evaluation Report dated May 22, 2000, were relevant to this study. In addition, a DWR levee rehabilitation study (1990) carried out in 1989-1990 was also utilized.

To supplement the existing information, additional subsurface explorations were carried out jointly by DWR and Reclamation in the summer and fall of 2001. The DWR exploration program consisted of drilling, logging and sampling a total of nine small-diameter borings using a hollow-stem-auger drill rig. Four of these logs are in the vicinity of the proposed structures. Reclamation performed a total of sixteen Cone Penetrometer Test (CPT) soundings through the existing levees at Webb Tract and Bacon Island. Of these, four borings and eight CPT soundings were carried out on Webb Tract, while the remaining five borings and eight CPT soundings were undertaken on Bacon Island. Copies of the boring and CPT logs are included in the referenced reports by Reclamation (2001) and DWR (2001).

The results of the field investigation and review of subsurface soil information presented in the referenced reports indicate that the site stratigraphy within the interior of the two islands (Webb Tract and Bacon Island) is reasonably consistent. Soft, organic clays and peat at the surface are underlain by fine-grained silty sand, which in turn is underlain by stiff clay and silt, and at greater depths, by medium to coarse-grained sand. Along the levees, an approximately 10-foot thick layer of fill consisting primarily of sand and clay soils with some organic overlies the peat soils. The combined thickness of organic clays and peat ranges from a minimum of 10 feet to a maximum of 40 feet.

5.2.4 Embankment Materials

In general, the upper portion of Delta levee embankments are comprised of mixtures of dredged organic and inorganic sandy, silty, or clayey soils placed on either natural peat or natural sand and silt levees. New construction fill materials would come from naturally occurring silty sand deposits located within the interior of the islands. Subsurface explorations indicate that the sand deposits are overlain by peat and organic soils of variable thickness, which will have to be excavated and removed to mine the sands. It is thus expected that minor amounts of peat soils would also get mixed into the fill. It would not be feasible to import select soil materials from offsite locations for use as fill.

Rock for concrete aggregates and riprap would be obtained from offsite sources. There are no suitable sources of rock for use as concrete aggregates or riprap within the Delta islands.

5.3 Review of Embankment Design

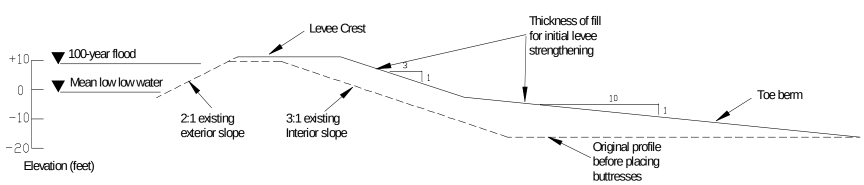
5.3.1 General Review of Delta Wetlands Embankment Design

Crest Elevation: DW proposes to use a standard Delta levee guidelines (e.g., Bulletin 192-82, PL 84-99) which will result in a levee crest elevation of approximately 9 feet above MSL. This elevation would meet the height criteria for the reservoir side only. River/slough side overtopping could occur with wave run-up action and crest elevations required are higher than 9 feet above MSL. The crest elevation required to prevent the design flood event on the river/slough side from overtopping the embankments would not be met along the entire perimeter. For Webb Tract, 46,000 linear feet of embankment (68%) would be overtopped and 16,000 linear feet (26%) would come close to being overtopped during the 100-year flood. For Bacon Island 26,800 linear feet of embankment (36%) would be overtopped and 32,400 linear feet (43%) would come close to being overtopped during the 100-year flood.

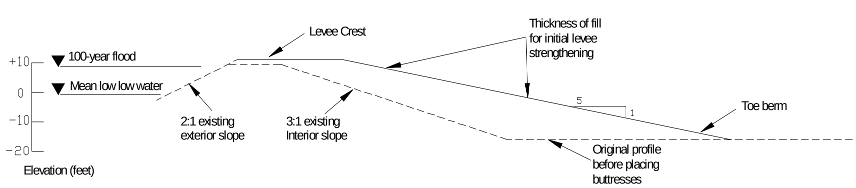
The 100-year flood elevation (design flood event) and wave heights information obtained from the *"CALFED Long-term Levee Protection Pla*n", September 1998 shows flood elevations vary from 6.6 to 7.4 feet above MSL. Wave heights vary from 0 to 8.2 feet based on the width of channel and the length of straight stretches of channel. Most wave heights are in the range of 1.7 to 4 feet with no to minimal waves generated in the canal and cut areas and 7- to 8-foot waves at the southern end of Webb Tract where Franks Island is inundated. Using this information, the required crest elevation to prevent overtopping will vary from 9.6 to 15.1 feet with an average of 10.2 feet on Bacon Island and 10.9 feet on Webb Tract. To reduce the possibility of overtopping, it is recommend that the height of the new structures should be the larger of the following two criteria: 1) the normal reservoir water storage elevation (4) plus wave run up and setup on the reservoir, but not less than 3 feet of freeboard and 2) water surface elevation of design flood on the river side plus the wave run up and setup, but not less than 3 feet of freeboard.

Crest Width: The 2001 Final EIS indicates that the embankments would be initially constructed with a 30-foot wide crest and have a final crest width of 22 feet after raising due to settlement. However, in a March 14, 2002 DW conversation with Reclamation/DWR, DW indicated that their design intent was to have a 35-foot total crest width at the end of initial construction. The crest width needs to provide for two-way traffic for construction, maintenance, and to facilitate future fill placement to maintain the crest elevation. Reclamation/DWR recommends that a final 35-foot width be used to facilitate long-term maintenance and repairs.

Embankment slopes: DW would not significantly alter the existing slopes on the slough side which vary between 2:1 and 3:1 (horizontal to vertical). On the island side, two design options are proposed, either a 5:1 embankment slope from crest to toe or a dual slope of 3 to 1 from the crest down to an elevation –3 MSL, and then 10 to 1 to the toe is proposed. These proposed embankment sections are shown on Figure 8.



a) Proposed Section with Break in Slope



b) Proposed Section with Constant Slope

Figure 8: EMBANKMENT SECTIONS PROPOSED BY DELTA WETLANDS

Slope Protection: The proposed slope protection on the exterior slopes is acceptable. On the reservoir side, the riprap should extend from the crest down to the island floor for the 5:1 slopes and to the slope break for the dual slope. The geotextile beneath the riprap would not be recommended because of the damage to it that will occur from long term settlement of the embankments. A standard sand and gravel bedding should be considered. To minimize the potential for a piping failure, DW proposes to place sand against the inside of the existing levees. No specifics of type of material, thickness, or basis for where it would be placed are provided.

5.3.2 Design Criteria

5.3.2.1 Classification of Structures

The purpose of classifying the earthfill structures is to define the design criteria that the embankments must be built and maintained to. USACE, State of California, and the Reclamation criteria and definitions given in a detailed "Draft Report on Engineering Investigations," May 2002 were reviewed, and it was determined that it is more appropriate to classify the proposed embankments as small dams and not levees.

5.3.2.2 Design Criteria Used by Delta Wetlands

The stability analysis done by URS (2000) for the DW Project identifies design criteria from various sources but does not specifically identify what was used in their study. It is stated that the criteria should be "based upon significance of the project; the consequences of failure (economic, environmental and other); the jurisdictional status of the reservoir under California Division of Safety of Dams (DSOD); and possibly other factors." The 1995 Draft EIR/EIS states "Levee improvements would be designed to meet or exceed state-recommended criteria for levees outlined in DWR Bulletin 192-82." This bulletin addresses "levee" design only and not structures used for water storage. Also, the bulletin does not provide design criteria but identifies a typical levee section and states that specific designs are required for each site.

5.3.2.3 Recommended Design Criteria

Selection of design criteria needs to consider the loading condition being analyzed and the consequences of failure, reliability of shear strength parameters and pore pressures assumed, level of field investigations, variability of existing conditions, and quality of construction control. The following are the recommended factors of safety for end-of construction, steady-state seepage, and sudden drawdown loading conditions. These values should be re-evaluated and adjusted based on the consequences of failure. A suitable design criteria based on consequences should be considered during final design.

> **End of construction -** The design criteria for USACE levee structure, DWR, and Reclamation dams all require a factor of safety of 1.3. This will be the requirement used for this study.
>
> **Steady-state seepage -** This is a critical design criteria since failure of the embankments would release water and could have economic consequences and potential loss of life including damage to adjacent islands. There is seldom much warning for these types of failures. This loading condition is seldom seen on levees because water does not remain against the structures for sufficient time to develop steady-state seepage condition. A factor of safety of 1.5 should be used. This is higher than what is typically required for levees.
>
> **Sudden drawdown -** A sudden or rapid drawdown is not expected to happen at these structures since releases are constricted by the pumping plant capacity, which is limited to 1.5 feet/day. However, a drawdown analysis should be performed since this rate of reservoir drawdown is still fast enough that pore pressures would not dissipate completely. A sudden drawdown could be created if a breach is artificially initiated at a fixed location to minimize the damages of an impending failure. Required factors of safety vary from 1.0 for levees to 1.3 for dams. It is recommended that 1.2 be used in this study.

5.3.2.4 Geometry

Configurations of Existing Conditions Used in DW Analyses: The criteria used by DW Project in selecting sections for analysis were the height of the existing levee and soil conditions affecting stability. Two sections for each island were chosen, Station 160+00 and 630+00 on Webb Tract and Station 25+00 and 265+00 on Bacon Island. DW states the sections are representative of the thickness of the levee fill from 6 to 10 feet, the thickness of the peat from 15 to 35 feet, 20-foot wide crest at elevation 8.5 feet, 2:1 slough side slope, and 4:1 island side slopes. It was noted in the URS' report (2000) that the most severe conditions that may be encountered may not have been analyzed and further data acquisition, additional analyses, and additional design configurations may be required during final design

Configurations of Existing Conditions Used in Reclamation/DWR Analyses: Each of the islands has over twelve miles of existing levees that will be modified under this project. Cross section data from the CALFED Levee Rehabilitation Study (1998) were used to determine configurations of the existing levees. That study had 148 cross sections for Bacon Island and 69 cross sections for Webb Tract. The Reclamation/DWR analysis done for this study took a more generic approach to determine the sensitivity of the factor of safety to geometry. Variation in existing embankment height, slopes, and thickness of peat were used in this analysis.

5.3.3 Results of Analyses on Delta Wetlands Proposed Embankments

5.3.3.1 Analysis by HLA (1989)

Preliminary geotechnical investigations and analyses were performed by HLA for DW. The proposed plan at that time was to store water in Bacon and Webb islands to elevation +6 feet. Eight cross sections, two for Webb Tract, two for Bacon Island, and four for other islands were analyzed for existing, end of construction, and long term conditions. The sudden drawdown condition was not specifically analyzed, and it was assumed that the factors of safety are greater than the end of construction case since both conditions use undrained strength and there would be strength gain as the materials consolidate with time. The cross sections analyzed did not include a widening of the crest. No changes to the slough/river side slopes were recommended. The factors of safety for the four cross sections on the islands and the various loading conditions are shown on Table 6. According to HLA's analysis, all conditions except the long-term (steady-state) condition for sliding towards the slough would meet the design criteria recommended in their report.

Table 6. HLA's ANALYSIS (1989) FACTORS OF SAFETY

Island Profile	Existing Condition		After Construction		Long-term	
	Slough	Island	Slough	Island	Slough	Island
Bacon #3 (Sta. 265)	1.6	1.2	1.5	1.6	1.6	1.8
Bacon #4(Sta. 25)	2.0	1.5	1.7	2.4	1.7	2.5
Webb #7(Sta. 160)	1.4	1.4	1.3	1.6	1.4	1.8
Webb #8(Sta. 630)	1.5	2.0	1.4	3.1	1.4	5.3
Design Criteria	n/a	n/a	1.3	1.3	1.5	1.5

5.3.3.2 DWR Levee Rehabilitation Study

In 1989, DWR undertook a study to develop generic levee designs based on levee height, foundation materials, construction materials, and land use. These studies concentrated on island side geometry to meet long-term levee stability. Published laboratory data and back calculations of known failures were used to develop the material strengths. The study developed a set of curves for island side slopes that would achieve a factor of safety of 1.3. In general, for low levee heights and/or small amounts of soft foundation soils, a 3:1 slope is sufficient. For large levee heights and thick layers of soft foundation materials, island side slopes of 7:1 or a berm with a slope of 13:1 may be required.

5.3.3.3 Design Review by URS (2001)

URS Greiner reviewed HLA's report for the SWRCB, and carried out additional slope stability analyses, as necessary, on the proposed new fills at Webb Track and Bacon Islands. The proposed new embankment configuration consisted of a crest elevation of +9 feet MSL, a crest width of 35 feet, and a 5:1 slope on the island side. In addition, an island slope of 3:1 from the crest to elevation -3 feet MSL and then a 10:1 slope were assumed for Sta. 630+00. It was assumed that water would be stored on the islands to elevation +6 MSL. The stations used in the HLA analyses were used in the URS analysis. Existing, end of construction, long term, and sudden drawdown static loading conditions were analyzed. The material properties used in analysis were based on published data and laboratory tests of materials from the site. As indicated in Table 7, minor variations in the material properties from those used in HLA's analyses, resulted in only small variations in factors of safety.

In addition, seismic-induced permanent deformations of the DW proposed embankments were estimated by URS. The deformations for the proposed embankments were estimated to be 1.5 to 3.5 feet for the island-side slope and 3 to 4 feet for the river/slough side slopes. The analyzed sections do not represent the most critical cross sections, and the analysis did not account for the loss of strength in the peat soils due to straining beyond fiber bond strength. The actual deformation could exceed these estimates.

5.3.3.4 Analysis by Reclamation/DWR (2001)

The adequacy of the embankment design proposed in the DW proposal was examined by Reclamation/DWR under varying slopes and subsurface soil conditions, based on which an alternative design was suggested. The properties of the peat soils used in the analysis, along with the analysis results are presented in Tables 8 and 9.

Post Liquefaction Stability: Information presented in the HLA and URS reports indicates the presence of liquefiable soils at the reservoir islands, a fact confirmed during the recent field investigation undertaken by Reclamation/DWR. Due to the presence of shallow ground water and the location of the islands within a seismically active region, the potential for liquefaction due to a seismic event is considered significant. A minimum factor of safety of 1.2 is typically required for post-liquefaction stability (see Table 7). DW did not carry out post liquefaction analyses as part of their proposal.

Table 7. FACTORS OF SAFETY FROM URS GREINER ANALYSIS (2000)*

Island Profile	Existing Condition		End of Construction		Long-term		Sudden Drawdown	
	Slough	Island	Slough	Island	Slough	Island	Slough	Island
Bacon Sta. 25+00	1.48	1.23	1.48	0.9	1.33	1.63	1.33	1.07
Bacon Sta.265+00	1.49	1.21	1.49	0.86	1.23	1.64	1.23	0.98
Webb Sta.160+00	1.29	1.24	1.29	0.62	1.12	1.57	1.12	0.88
Webb Sta.630+00	1.34	1.40	1.34	0.89	1.12	1.82	1.12	1.18
Webb *Sta.630+00	-	-	-	1.22	1.12	1.71	-	1.04
Design Criteria	n/a	n/a	1.3	1.3	1.5	1.5	1.2	1.2

**New fill has 3:1 slope flattening to 10:1 at elevation -3.*

Table 8
RECLAMATION/DWR FACTORS OF SAFETY FOR STEADY STATE CONDITION AND SLIDING TOWARDS THE RIVER/SLOUGH*

<table>
<tr><th rowspan="2">Slope (H:V) Above Elevation 0</th><th rowspan="2">Peat Strength Free field//under dam//cohesion (phi//phi//psf)</th><th colspan="4">Factor of Safety* 10' embankment</th><th colspan="4">Factor of Safety* 18' embankment</th></tr>
<tr><th colspan="2">10' peat</th><th colspan="2">30' peat</th><th colspan="2">10' peat</th><th colspan="2">30' peat</th></tr>
<tr><td>2:1 (DW)</td><td>30//0</td><td>.95</td><td>1.55</td><td colspan="2">.95</td><td colspan="2">1.24</td><td colspan="2">1.14</td></tr>
<tr><td>3:1</td><td>30//0</td><td colspan="2">1.13</td><td colspan="2">1.04</td><td colspan="2">1.37</td><td colspan="2">1.19</td></tr>
<tr><td>4:1</td><td>30//0</td><td>1.33</td><td>1.54</td><td colspan="2">1.13</td><td colspan="2">1.51</td><td colspan="2">1.24</td></tr>
<tr><td>2:1</td><td>26//28//50</td><td>1.19</td><td>1.68</td><td>1.16</td><td>1.28</td><td>1.43</td><td>1.65</td><td>1.25</td><td>1.31</td></tr>
<tr><td>3:1</td><td>26//28//50</td><td>1.31</td><td>1.88</td><td>1.24</td><td>1.39</td><td>1.51</td><td>1.79</td><td>1.29</td><td>1.35</td></tr>
<tr><td>4:1</td><td>26//28//50</td><td>1.56</td><td>2.34</td><td>1.39</td><td>1.64</td><td>1.73</td><td>2.29</td><td>1.43</td><td>1.59</td></tr>
<tr><td>2:1</td><td>15//19//100</td><td colspan="2">1.2</td><td colspan="2">1.08</td><td colspan="2">1.36</td><td colspan="2">1.1</td></tr>
<tr><td>3:1</td><td>15//19//100</td><td colspan="2">1.28</td><td colspan="2">1.12</td><td colspan="2">1.43</td><td colspan="2">1.17</td></tr>
<tr><td>4:1</td><td>15//19//100</td><td colspan="2">1.46</td><td colspan="2">1.17</td><td colspan="2">1.53</td><td colspan="2">1.22</td></tr>
</table>

** Where there are two values reported, the first value is the factor of safety that takes out only a portion of the crest and the other factor of safety is for a sliding surface that includes the entire crest.*

Table 9
RECLAMATION/DWR FACTORS OF SAFETY FOR STEADY STATE CONDITION AND SLIDING TOWARDS THE ISLAND*

Trial Number	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Height of Existing Embankment, feet	10	10	10	24	24	24	16	16
Thickness of peat, feet	10	20	40	10	20	40	20	30
New Crest Elevation	10	10	10	10	10	10	15	15
Factor of Safety	1.75	1.41	1.26	2.71	1.96	1.49	1.67	1.46

**Assuming existing slope is 4:1, new slope is 3:1 to elevation +4 and then 10:1, slough side slope is cut back, and a new crest width of 35 feet, reservoir empty and river at elevation +6.*

Piping: The potential for piping failure due to seepage through embankments and through cracks resulting from differential settlement exists at the subject islands. No quantitative analyses have been performed to evaluate the potential for piping failure, and the DW design does not include any specific measures to reduce the potential for piping failure.

Seismic: The 2000 CALFED report concluded, "attempting to significantly reduce seismic levee fragility will be both difficult and expensive, and that simply making relatively minor geometric modifications will not significantly reduce seismic vulnerability. Developing improved emergency response plans and measures (including stockpiling critical materials and equipment) is thought to have considerable merit, especially in the short term."

5.3.3.5 Delta Wetlands Project Risk Analysis by URS

URS carried out a risk analysis of DW project failure due to operational, flooding and seismic events. The purpose of the analysis was to assess the severity and consequences of failure of the proposed DW project and evaluate its impact on the environment, water quality, reliability of supplies, facilities and infrastructure, economics, public health and safety, and land use. The conclusions of this study are as follows:

- While the reservoir-side slopes have adequate factors of safety against stability failure for long-term steady-state seepage, the safety factors for the slough-side slope do not meet criteria (see Table 8). The safety factors against failure in case of a sudden drawdown also do not meet criteria.
- Earthquake events could cause excessive deformations of the proposed embankments, leading to cracking and potential failure.
- The proposed embankment crest elevation is deficient with respect to flood events. Overtopping would be caused by wind set-up and wave run-up.
- In the absence of interceptor wells, the exit gradients in the sloughs and adjacent islands would be high and could cause piping and failure. The proposed interceptor wells are expected to be able to control the adverse seepage conditions. However, the potential loss of power supply during a major event could significantly impede the operation of these wells.

5.3.3.6 River/Slough Side Levee Review by California Department of Fish and Game

During the development of the DW project description it was concluded by DFG that the waterside of the exterior levees on the reservoir islands would not need to be significantly modified beyond the levee improvement work accomplished over the last ten years. The DFG does not support the proposal to remove all vegetation on the exterior levees on the project islands, specifically reservoir islands. DFG believes that maintenance of exterior levee vegetation, in any manner, should be consistent with the DFG's AB 360 Levee Program. To simply remove all vegetation will degrade the habitat value of both shallow water emergent and riparian habitats that may be present or develop on the islands during the life of the project. DFG recommended that a maintenance program for the embankment be developed that is consistent with the AB 360 Levee Program.

5.3.4 Reclamation/DWR Re-engineered Design

Steady-state Condition with Sliding Towards River/Slough –Reclamation/DWR analysis indicate that the slopes of the embankments on the river/slough side could be flattened during initial construction to increase the factor of safety against a sliding failure. Careful construction control would be required to minimize environmental impact. Flattening of the slope will require the centerline of the embankments to be shifted towards the island side and increase overall fill quantities. However, the excavated material can be used in the construction of the new fill. The slopes needed to increase the factor of safety to the design criteria will vary depending upon depth of channel, thickness of peat, strength of peat, and height of embankments. Based on the results of the analysis, a flatter slope may be required than the existing slope on the river/slough side. During final design more specific analyses should be done to determine actual slopes needed based on additional topographic data. Future designs should also consider alternative techniques to increase the stability of the river/slough slopes without any damage to the shallow water habitat.

Steady-state Condition with Sliding Towards the Island Side - Based on previous analyses and some additional recently done analyses, Reclamation/DWR recommend that at this level of study a slope of 3:1 down to elevation +4 feet and a slope of 10:1 below that elevation should be used. More complete analysis should be done during final design to optimize slopes for different reaches of the embankments with different geometry and foundation conditions.

The embankment section proposed by Reclamation/DWR, which is applicable to all three project alternatives, is illustrated in Figure 9. A minimum crest width of 35 feet has been proposed. The existing slough-side slopes vary. Depending on the strength of material estimate, analysis indicated that existing slough slope may need to be flattened to 3:1 or 4:1. However, environmental consequences of flattening slough-side slopes may be serious and costly and will affect in-stream habitat. Further evaluations are required. For estimation purposes, it was assumed that a range of costs will be shown with the existing slough-side slopes modified to 3:1 under the DFG AB 360 Levee Maintenance Program and alternatively showing a higher range of cost for cutting back existing slough side slope to 4:1 above elevation 0. On the island-side, the embankments would descend from the crest at a slope of 3:1 to an elevation of +4 MSL, and 10:1 thereafter. The embankment crest elevations would vary, depending on the reservoir water storage elevation, the expected wave run up, the design floodwater surface elevation and an appropriate freeboard.

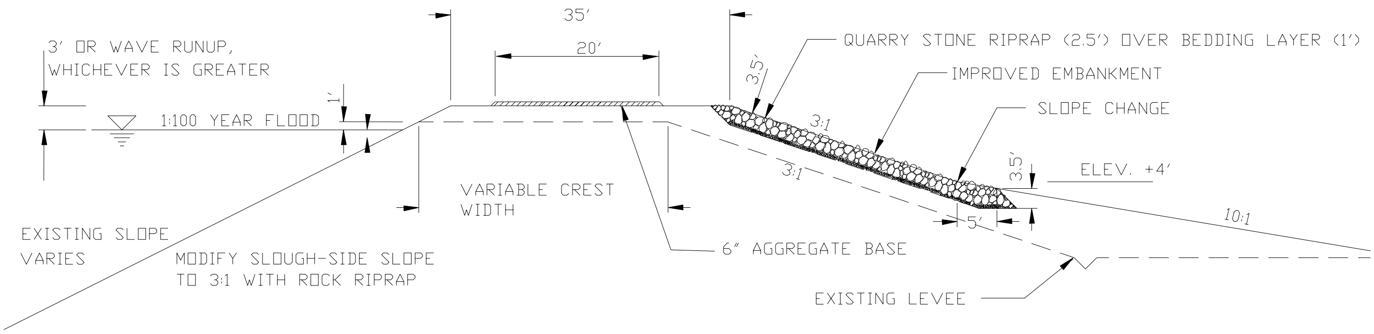


Figure 9: PROPOSED EMBANKMENT SECTION WITH MODIFIED SLOUGH-SIDE SLOPE AND VARIABLE ISLAND-SIDE SLOPE

5.3.5 Design Review Summary

5.3.5.1 Embankment Design

Reclamation and DWR conclude that it is technically feasible to modify the existing levees to provide structures for a durable water retention facility. Based on the review of DW analyses and conclusions and analyses done by others, the following conclusions have been made:

- The method of analysis and assumptions used in the DW analyses are appropriate for this level of study.

- The embankments should not be considered levees because of the longer duration of water stored against them and the different consequences if failure were to occur. Reclamation/DWR assumed it more appropriate to use embankment design criteria similar to small dams rather than Delta levee criteria for the current study. Additional risk analysis should be performed to address this issue in detail.

- Staged construction over several years will be required to construct the new embankments. A five year construction period is assumed but further analysis will be required to refine this estimate.

- DW proposed river/slough side slopes indicated lower factor of safety for steady state conditions. Further evaluation of the river/slough side slope should be undertaken with due consideration to environmental and slope stability.

- A slightly different island side slope configuration is selected for use as an average configuration for computing quantities at this level of study. It is recommended that a slope of 3:1 down to elevation 4 feet, followed by 10:1 below that elevation, be utilized. More complete analysis should be done during final design to optimize slopes for different reaches of the embankments with different geometry and foundation conditions. A minimum of 35 feet of crest width should be provided for two-way traffic. To show a range of costs, existing slope maintenance and alternatively 4:1 slope on the river/slough side is used for cost estimating purposes.

- Additional data acquisition and analyses should be done during final design to refine required cross sections along differing reaches of the embankment.

5.3.5.2 Seepage

Reservoir seepage is expected to cause water levels to rise under adjacent islands. Measures to control this seepage are needed. Interceptor wells through the embankments around the reservoir or interceptor drains on adjacent islands can be used to control seepage. Site-specific field hydraulic conductivity tests are needed to refine seepage estimates. A model to address seepage to drains should be developed.

5.3.5.3 Settlement

Significant settlement is expected during construction and over the life of the embankments. The amount of settlement will vary depending upon peat thickness and fill height. Analysis done by DW Properties indicates that additional fill is required, but the specific assumption has not been provided. Based on the above analyses Reclamation/DWR made the following assumption for this study:

- Increase initial fill volume by a factor of 2.25
- Construction will take at least 5 years
- Place an additional 25% of the fill volume 15 years after construction

The actual amount of additional fill required to compensate for the settlement should be estimated during final design. In addition, consideration should be given to overbuilding the embankments during initial construction and subsequent modification to ensure adequate crest elevation is maintained at all times and to prevent overtopping during the design flood event.

The DW Project did not mention any specific method that would control piping and prevent piping failure. Reclamation/DWR assumed that a sand filter, of some type and location, would be required to prevent a piping failure. For cost estimating purposes only, a vertical filter through the middle of the embankments was assumed. Additional measures should be identified and evaluated during final design.

5.3.6 Review of DW Proposed Fish Screens, Siphons and Pumping Units Design

For diversion of water to the islands, a total of 64 new siphons are proposed at the two reservoir islands, with each island having 32 siphons, barrel type fish screens and booster pumps. There are 35 existing siphons on the reservoir islands and 18 existing siphons on the habitat islands. In DW studies a maximum design flow of 5,500 cfs was used for the reservoir islands siphons and pumping diversion structures and 400 cfs diversion flow was used for the existing habitat island siphons.

For the release of water, a new discharge pump station is proposed at each island, with the station at Webb Tract consisting of 32 pumps and the Bacon Island pump station containing 40 pumps. To prevent seepage of stored water into neighboring islands, a total of 773 pumps would be installed around the perimeter of the reservoir islands to intercept and pump water back to the reservoirs.

All new and existing siphon intake will be provided with a barrel-type fish screen and a hinged flange connection at the water surface to allow rotation of the screen for manual cleaning and repair. Typical drawings for DW Project fish screens, siphons and pumping stations are shown on Figure 12 in Appendix B.

5.3.6.1 Diversion Capacity

With 64 new siphons for the reservoir islands, each siphon will carry a flow of 86 cfs. The flow velocity through a 3 feet diameter pipe will be about 12 feet per second. The existing siphons being old may need to be extended or replaced during construction. The DW proposed pumps on the new 64 siphons. Design may also require additional new siphons or two more manageable size 40 cfs flow fish screens may have be coupled to achieve a total flow of 5,500 cfs. The siphon station design as proposed needs to be modified to meet the fisheries requirements.

5.3.6.2 Evaluation of DW Proposed Structures by URS/CH2M Hill

A review of the structures proposed in the DW proposal was carried out jointly by CH2M HILL and URS. The study entailed identifying issues of concern related to structural stability, operational and maintenance of the fish screens, siphons and pumping units, and estimating the annual costs associates with these issues. Detailed findings of the study are presented in the referenced report (URS/CH2M Hill, November 2001). Pertinent sections of the report are summarized below.

Fish Screens: The study indicates the fish screen design proposed by DW does not meet compliance requirements established by the fisheries agencies. The major areas of non-compliance relate to cleaning requirements, screen mesh (and perforated plate opening size), and screen area. In addition, the study indicated that the proposed design would be very difficult and expensive to operate and maintain due to the following reasons:

- No automatic screen cleaning system
- Poorly retrievable system – even when raised, the screen will be subject to corrosion, and will have poor access for inspection
- No monitoring system
- Dissimilar metals on pie and screen
- Woven wire screen (stainless steel is good but not resistant to biofouling)
- Structural inadequacy

In general, the URS/CH2M HILL study revealed that the proposed fish screens do not appear to satisfy considerations related to structural, hydraulic and geotechnical design; and operations and maintenance. Based on these findings, the study concluded that the proposed fish screen design was “deficient, or a risky design.”

Pumps/Siphons: The URS/CH2M HILL study points out that the applicability of the DW project concept is unproven at its proposed scale, and suggests that smaller and more manageable facilities may be required. Downsizing each diversion may result in a more manageable sized, say to 40 cfs, screen unit as recommended by DFG in their Criteria for Fish Screen Design. Therefore, the number and complexity of the intake pipes and facilities will increase four fold, or to approximately 248 new diversion structures and pipelines. Additional 72 pumping and siphon units will be required for release of water. Within this concept, it is recommended that each of these screens be designed and equipped with automatic cleaning systems, retrievable screen systems, cathodic protection, wedgewire screens, monitoring systems, and be able to withstand higher structural loads and pressures. The resulting redesigned cylindrical screens may be manageable on an individual level, but unmanageable when considered as a whole. Finally, the study concludes that consolidated facilities with flat plate screen technologies may be more pertinent for the planned application.

5.3.7 Integrated Facilities

As mentioned previously, evaluation of the proposed DW structures by DWR, Reclamation, and consultants indicated several structural, environmental, and operational and maintenance problems. Management of the proposed structures would need continuous annual expenditures, which cannot be justified over long-term operations. It is recommended that a consolidated design be developed for intake and outlet facilities due to the following reasons.

- Avoid or reduce high annual operational and maintenance costs
- Risk of failure of these structures and impacts on adjacent lands
- Importance of uninterrupted supplies
- Impacts of high velocities adjacent to fish screens on fisheries
- Importance of meeting DWR and Reclamation design standards for unique nature of soils in the Delta
- Environmental and recreational use implications around 193 small structures overlying embankments

Consolidated diversion facilities may offer a better solution. Engineered, flat plate screened diversion along river banks have proven to be extremely reliable under a wide variety of flows and conditions, including the Delta. With these issues in mind, it is the suggestion of Reclamation/DWR that instead of the multifarious pumps, siphons and fish screens proposed by DW, integrated facilities, consolidating the diversion and discharge operations should be considered.

The components of each integrated facility will include a pumping plant, inlet/outlet gates, outflow channel and fish screens. A plan view of a typical integrated facility is included with this report as Figure 10. A combination of two gated structures and a low pool is proposed to provide coordinated operations with the pumping plant, under various flow conditions. The manipulation of the gates would allow the flow to be directed for diversions onto the reservoir island or releasing the water back into the adjacent channel. To minimize fish entrapment, continuously cleaned, flat plate fish screens will be provided on the inlet channel of each integrated facility.

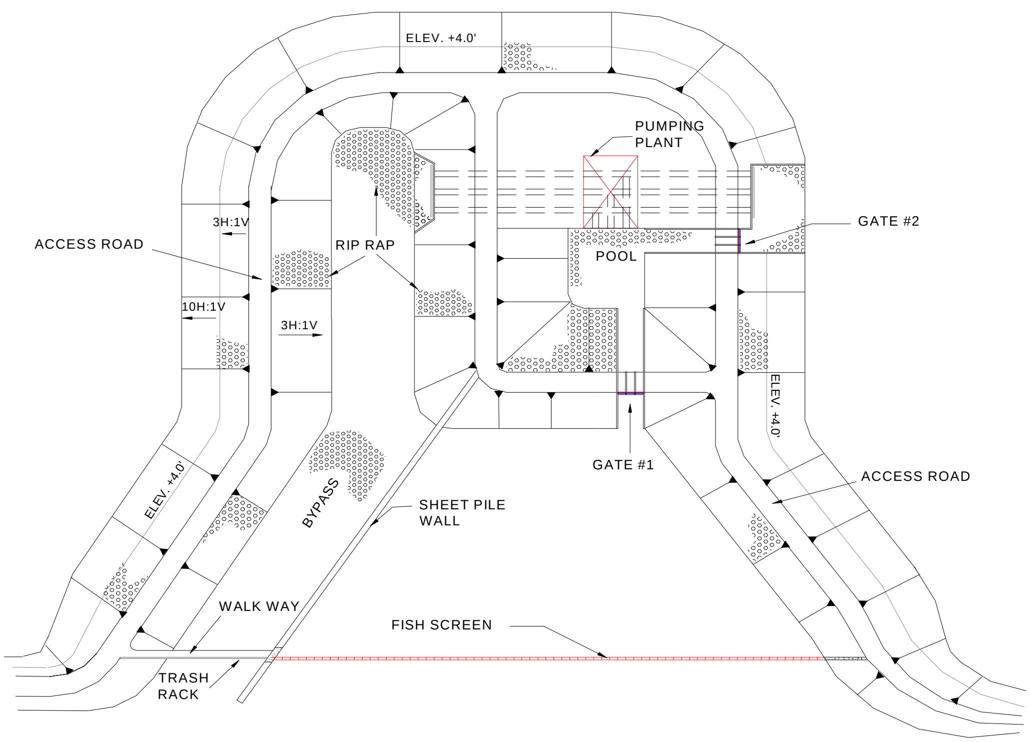


Figure 10: TYPICAL INTEGRATED FACILITY

Integrated Facility Site Selection: To serve the main purpose of diversion and release of stored water for various uses, the facilities need to be located in areas of minimal sensitivity to environment. The following factors were considered in the selection of sites for the facilities:

- Topography of the area
- Access to different water sources
- Impact of released water quality on urban intakes
- Slough conditions in relation to environmentally sensitive areas
- SWRCB Water Right Permit restrictions

Integrated Facility Design Concept Development: For diversions, an integrated facility should be able to divert water for all ranges of river flows. As the reservoir islands are at lower level than the river, there are times when water can flow into the reservoir with gravity or a combination of gravity and pumping will provide the desired flow. When the river level is lower than the reservoir, pumping will be required.

For releases, flow conditions similar to diversion may prevail and reservoir operations may be reversed for gravity, combination of gravity and pumping, and pumping only flow conditions. Also, fish screening is necessary to provide protection and minimize fish mortality.

The following design concepts for structure components were developed.

Fish Screen Intakes: To meet the 0.2 feet per second approach velocity criteria, a wider inlet section is needed. On the other hand, gated structures required for flow control have narrow sections with higher flow velocities. A long transition structure from a wider section to a narrower section will be necessary.

Gate Controls: The gates in an integrated facility are to serve the following purposes: control the direction of flow during pumped or gravity flow, control the flow velocity during pumped flow, and regulate the flow during gravity flow. These are discussed below and require careful consideration during design of the gates.

- <u>Control of Flow Direction:</u> The gates will direct the pumped or gravity flow from the river into the reservoir (diversion), or from the reservoir into the river (release).

- <u>Control of Velocity at the Gates:</u> For pumped discharge, the velocity at the maximum gate opening should be less than or equal to the velocity at the pump intake.

- <u>Flow Regulation:</u> During gravity flow, when the elevation difference between the river and the reservoir water surface is relatively high, the diversion rate or the release rate may exceed those allowed by the applicable permit, unless regulated by the gate opening. The gate opening can be controlled (based on the gate’s discharge vs. head rating) to limit the discharge to the permitted value.

Pumping Plants: The pumping facilities should be capable of diverting water from the adjacent river into the reservoir and also releasing water back into the river. The criteria for the pump setting was to keep the pump impeller or the turbine blades submerged at all times. Pump flow rating is to be based on the design flow rates (the maximum of diversion and release flow rates) and the total dynamic head (TDH) on the pump. The TDH is the sum of the static head and all the hydraulic head losses in the system. The static head is computed as the difference in water level elevation between the river and the reservoir.

Pools and Channels: Each integrated facility will require a 'Low Pool' and a 'Bypass Channel'. The purpose of providing these components is as follows:

- Low Pool: The pump intakes are kept submerged to eliminate any air suction and cavitation problems. The low pool provides a pool of water at the pump intake and also creates submerged flow condition for higher velocity water passing through the gate area. The pool is to be made sufficiently deep to cover the entire diameter of the intake pipe. The top of the pipe intake is set below the lowest operational water surface in the river or the reservoir dead storage water level (whichever is lower) to keep the intake pipe submerged under all operational conditions of the river and the reservoir. The pool is to be made sufficiently long and wide to provide space for intake pipes of the pumping plant and to facilitate periodic maintenance including removal of sediments using mechanical equipment.

- Bypass Channel: A Bypass Channel is to be created at the discharge end of the pumping plant for receiving the pumping plant discharge and conveying it to the river. It also conveys gravity flows from the reservoir to the river when the elevation difference between the river and the reservoir water surfaces permits gravity flow.

5.3.8 Relocations

The reservoir islands are agricultural areas with negligible urban development. There are several installations associated with agricultural operations including processing plants, warehouses, and canneries that would have to be relocated before filling of the reservoirs. Other relocations consist of public and private infrastructure, the most significant being a PG&E gas pipeline passing through Bacon Island, and Highway 4 passing through Victoria Island. The pre-feasibility study cost of $9.2 million was used for PG&E gas pipeline in this study.

5.3.9 Project Costs

It was decided by Reclamation and DWR that a cost range based on uncertainties be included in this evaluation for the Re-engineered DW Project. These uncertainties such as the extent of design based on level of protection, site conditions and construction methods, unit cost variations, and changes in hydrology, are explained under sensitivity analysis in Section 5.3.10.

A low range cost summary of the three alternatives is presented in Table 10. These costs are based on a modifications to the existing slopes on the slough-side and adding additional embankment section on the reservoir side with variable slopes of 3:1 down to plus 4 above MSL and 10:1 to the toe of the embankment. It is assumed that an annual embankment maintenance program will be developed under the DFG AB 360 Levee Maintenance Program. The modified slough-side 3:1 slope will be maintained with annual maintenance and these costs are also included in the annual operation and maintenance costs given in Table 10.

Although preliminary cost evaluations were done for the DW proposal, these are not included in this report. The DW Project does not meet the design standards imposed on the Re-engineered and other alternatives for public ownership. Showing costs for a project that does not meet design standards is not a fair comparison.

Unit costs are based on Reclamation and DWR experience of construction in the Delta and costs used in the previous CALFED/Reclamation/DWR pre-feasibility studies. Previous studies information was updated with the Engineering News Record Index to bring it to the present level cost. Detailed cost estimates for items shown in Table 10 are given in Appendix C of the "In-Delta Storage Draft Report on Engineering Investigations," May 2002. Sherman Island Reservoir preliminary costs were also estimated for information and comparison purposes only and are approximately $ 837.6 millions for a storage capacity of 179 TAF.

Table 10
IN-DELTA STORAGE PRELIMINARY ENGINEERING AND CONSTRUCTION COST ESTIMATES
(Note: Costs will be rounded off to the nearest $1,000)

Cost Item	Project Alternatives (Low Range Costs)		
	Re-engineered Delta Wetlands	Bacon/Victoria with Connection to Clifton Court	Webb/Victoria with Connection to Clifton Court
Integrated Facilities	$ 104,733,000	$ 95,855,000	$ 96,698,000
Fish Screens	$ 60,000,000	$60,000,000	$60,000,000
Seepage Control System	$ 10,634,000	$5,000,000	$5,000,000
Land Acquisition	$ 59,814,000	$64,998,000	$64,770,000
Facilities (conveyance to CCF)		$36,910,000	$36,910,000
Island Embankments	$ 144,559,000	$152,523,000	$152,154,000
Demolition and Cleanup	$ 8,100,000	$8,100,000	$8,100,000
Permits	$ 300,000	$300,000	$300,000
New Utilities/Relocations	$ 12,380,000	$63,134,000	$53,934,000
Interior Work	$ 2,400,000	$2,400,000	$2,400,000
Mitigation	$ 21,000,000	$21,000,000	$21,000,000
Subtotal	**$423,920,000**	**$510,220,000**	**$501,266,000**
Mobilization (5%)	$21,196,000	$25,511,000	$25,063,000
Contingencies/Unlisted Items (20%)	$84,784,000	$102,044,000	$100,253,000
Contract Cost Subtotal	**$529,900,000**	**$637,775,000**	**$626,582,000**
Eng., Legal and Admin.(25%)	$132,475,000	$159,444,000	$156,644,000
TOTAL PROJECT COST (Rounded)	**$662,375,000**	**$797,219,000**	**$783,228,000**
ANNUAL OPERATION AND MAINTENANCE COST	**$8,334,000**	**$8,358,000**	**$8,299,000**

5.3.9.1 Contingency and Engineering Costs

An initial mobilization cost of 5% was assumed. Project contingency costs were assumed to be equal to 20% of the base construction estimates. The engineering, legal and administrative costs were assumed to be equal to 25% of the subtotal of the base construction estimates plus contingencies. This cost component would account for project planning as well as engineering design (conceptual through final) and construction management. Lastly, legal and administrative costs associated with land acquisition, construction contracts and infrastructure relocation are considered in this component. Both of these assumptions are typical for projects of this magnitude.

5.3.9.2 Annual Maintenance and Operation Costs

Annual maintenance and operation costs for various alternatives are given in Table 10. These costs include costs for: embankment maintenance, pumps, conduits and fish screens maintenance, seepage system operation and monitoring, habitat islands operations, fisheries mitigation and monitoring, weed control, cultural resources mitigation and in-lieu payments for property taxes. Further details are presented in Appendix C of the "In-Delta Storage Program Draft Report on Engineering Investigations," May 2002.

5.3.10 Sensitivity Analysis

It was decided by Reclamation and DWR that a cost range based on uncertainties be included in this evaluation. The proposed project costs may vary depending on a number of factors such as the extent of design based on level of protection, site conditions and construction methods, unit cost variations, and changes in hydrology. A sensitivity analysis was done to determine the potential change in low range cost given in Table 10 due to variations in the Re-engineered DW Project design, impact on unit costs due to site conditions and potential problems during construction, and seasonal variations in design inflows due to climate change.

5.3.10.1 Cost Variations based on Design

The following factors were considered.

- **Embankment Slopes:** Changes in the slough-side embankment slopes from the existing slopes to achieve higher factors of safety can cause the following variation in cost.

    - Embankment costs will include excavation of slough-side slopes under water and above to flatten slough-side to a 4:1 slope.
    - New embankment with 4:1 slough-side slope will be starting at a location inside the existing embankment due to embankment crest starting at a point anywhere from 15 to 30 feet inside towards the island. It will practically be a new embankment and costs will be much higher than the costs shown in Table 10.
    - Mitigation costs for shallow water habitat and in stream botanical resources. These costs alone can vary from $100 million to $200 million and depending on the potential of damage to fisheries and other resources in the area can also end up in a Jeopardy Decision.

- **Piping Protection:** A sand filter or some other measure like slurry wall may be required for piping protection. Additional work in this area is required to minimize the possibility of piping failures due to settlement-related cracking. The Independent Board of Consultants recommended against installation of such a filter during the construction or initial stages of the project because it stands a higher risk of construction and post-construction damage. Costs of installing a sand filter were included for both low and high range of costs as a placeholder for piping protection. However, these costs may be different if a slurry wall is selected as a measure for piping protection.

The Independent Board of Consultants recommended that physical design should be integrated with the level of protection. A detailed risk analysis is required to determine a reasonable level of protection. Further design evaluations are recommended for the final design.

5.3.10.2 Cost Variations based on Site Conditions and Construction Methods

Information on construction methods and unit costs is available from the past 10 years of construction experience in the Delta and discussions with DW. The Reclamation Districts are maintaining Delta levees and DWR pays 75% of the maintenance costs. However, during preliminary cost assessment process, it became evident that differences of opinion exist on the unit costs. The following variations in cost were identified.

- The present levee maintenance indicates $5 to $6 per cubic yard of embankment fill. However, if in future borrow areas are identified to be under the peat layer and removal of organic materials and dewatering is required, this cost may vary from $8 to $15 per cubic yard. A cost of $8 per cubic yard was used for low range estimate and $15 per cubic yard was used for high range estimate.
- Riprap costs in the Delta vary from $18 to $20 per ton based on recent construction costs. However, unit costs may be higher depending on site access problems and other factors such as delivery, placement, overhead and profit, and union wage rates. Considering these factors, unit costs varying from $26 per ton to $39 per ton were used for rock riprap.

A higher range of cost considering design variations included in the sensitivity analysis is shown in Table 11. Details of these costs are presented in Appendix C of the "In-Delta Storage Program Draft Report on Engineering Investigations," May 2002.

Table 11
RE-ENGINEERED DELTA WETLANDS PROJECT COST VARIATION DUE TO CHANGES IN DESIGN
(Note: Costs will be rounded off to the nearest $1,000)

Item	Re-engineered Delta Wetlands (High Range)
Integrated Facilities	$132,864,000
Fish Screens	$60,000,000
Seepage Control System	$10,634,000
Land Acquisition	$59,814,000
Facilities (conveyance to CCF)	
Island Embankments	$276,505,000
Demolition and Cleanup	$8,100,000
Permits	$300,000
New Utilities/Relocations	$12,380,000
Interior Work	$2,400,000
Mitigation	$121,000,000
Subtotal	**$683,997,000**
Mobilization (5%)	$34,200,000
Contingencies/Unlisted Items (20%)	$136,799,000
Contract Cost Subtotal	**$854,996,000**
Eng., Legal and Admin.(25%)	$213,749,000
TOTAL PROJECT COST (Rounded off to nearest $1,000)	**$1,068,745,000**

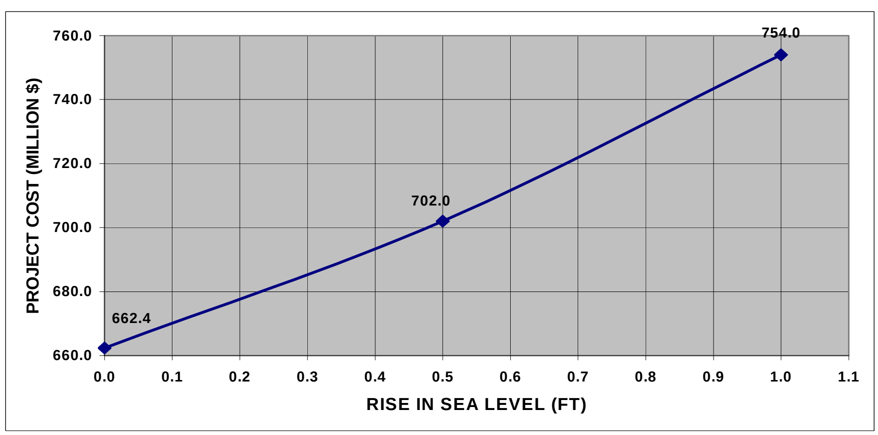
5.3.10.3 Climate Change Impact

Global warming and rise in sea level may cause additional problems for the embankments as designed, due to the potential for failure by overtopping. The crests of the embankments will need to be raised in future to meet water level changes due to this potential change in climate.

Instead of 1:100-year flood presently considered for design, a higher magnitude like 1:300-year flood may become the controlling design criteria for embankments and structural designs. Such a flood may require that height of works be increased by 0.5 to 1.0 foot. Risk Analyses indicates that there is 16% probability of over topping of the DW Project during the assumed 50-year life of the project.

Increase in project quantities and costs: Increased height to provide for protection as a result of potential rise in sea levels due to climate change will require that embankments and structures be built to withstand failures. Two increases in height were assumed for sensitivity analyses: 0.5 and 1.0 foot. Figure 11 shows the variation of costs due to potential rise in sea levels. If the project is designed and build for the presently accepted design criteria of 1:100 year flood,

Figure 11: DELTA WETLANDS RE-ENGINEERED PROJECT COSTS DUE TO RISE IN SEA LEVEL



this additional cost may be spread over the next 50 years of the Project life in the form of increased annual maintenance and operation cost to avoid over topping and failures. As the base cost of $662.4 million may increase to $1.1 billion due to changes in design, unit cost, site conditions and construction methods, costs shown in Figure 11 for 0.5 and 1.0 foot levels may increase by 10 to 15% due to these factors.

5.4 Key Findings and Conclusions

Based on the engineering design review, risk analyses and evaluations completed for the proposed Fish Screens, Siphons and Pumping stations of the DW Project, the following conclusions were made:

- The proposed conceptual design for embankment for Webb Tract and Bacon Island does not meet DWR and Reclamation design standards for public ownership.
- Inlet and outlet structures as proposed by DW are not structurally sound and need modifications.
- Analyses conducted to assess the risk of embankment failure due to operational, seismic and flooding events concludes that risk of failure exists in all three areas. Overtopping of the proposed embankments on Webb Tract and Bacon Island may occur during a 100-year flood. Consequences of failure could be similar to the existing conditions and could include salinity intrusion, interruption in reservoir operations, and impacts to biological resources including fish entrainment.
- Due to the potential for seepage pumps to not operate during power outages, improvements in the proposed seepage control system should be investigated.
- Global warming and sea level rise may add additional constraints for the embankment as designed. Embankments may need to be raised to meet water level changes due to potential climate change.

5.5 Recommendations

- Solutions should be developed to enhance project reliability through improved design and consolidation of inlet and outlet structures.
- Embankment performance reliability can be improved with appropriate changes such as flatter slopes, wider crest, and possibly higher embankment. These and other solutions leading to overall system improvement are feasible and should be part of future studies.

Chapter 6
ENVIRONMENTAL EVALUATIONS

6.1 General

Environmental studies were conducted to evaluate the DW Project as proposed and two alternative proposals that provide additional operational flexibility to CVPIA actions, environmental needs, and other uses. The evaluations assumed public ownership of the DW Project and focused on identifying environmental deficiencies in project design and in the environmental analysis given public ownership. The evaluations were based on previous surveys, studies, and existing information available at the time of the study. The areas covered in the study included:

- Land use resources
- Botanical resources
- Aquatic resources
- Wildlife resources
- Cultural resources
- Hazardous materials
- Recreation

Detailed information on the environmental evaluations are available in "In-Delta Storage Program Draft Environmental Evaluations," May 2002.

6.2 Delta Wetlands Project

The information contained in this section has, unless otherwise noted, been extracted from the draft, revised, and final EIR/EIS prepared for the DW Project by Jones & Stokes, the CESA Incidental Take Permit, the USFWS and NMFS Biological Opinions, and SWRCB Decision 1643.

6.2.1 Land Use

Land use information for the DW Project islands was updated using DWR Land Use Survey Data from 1995 and 1996.

DW Properties owns all the project islands except for 1,120 acres on Holland Tract. The majority of all the islands are in agricultural use (Table 12). Webb Tract and Bouldin Island produced mainly corn and grain crops. Holland Tract produced mainly grain, safflower and corn. Crops grown on Bacon Island included corn, sunflowers, grain, and potatoes.

Table 12
LAND USE ON THE DELTA WETLANDS PROJECT ISLANDS

Island	Agricultural Production (acres)	Native Vegetation and Open Water (acres)
Webb Tract[a]	4780	722
Bouldin Island[a]	5352	642
Holland Tract[b]	2790	319
Bacon Island[a]	5152	420
Total	18,074	2103

[a]Additional land is in uses such as farm buildings, homes, etc.
[b]Land not owned by DW is excluded from this table.

The DW Project will result in two significant adverse impacts to agricultural land. The project will convert prime agricultural to nonagricultural uses and conflict with land use plans. Approximately 15,000 acres of prime agricultural land would be converted to non-agricultural uses under the DW Project. The conversion is inconsistent with the DPC's land use goals to preserve prime agricultural land for agricultural production.

DW Project did not propose mitigation to minimize impacts to agricultural land. The SWRCB issued a Statement of Overriding Considerations in D-1643 and considered the project's value to water supply to outweigh the importance of maintaining agriculture on the islands.

The CALFED ROD requires all CALFED projects to evaluate effects and minimize impacts to agricultural land. If the DW Project becomes a public project, the project should comply with the Farmland Protection Policy Act and should include mitigation measures for the loss of agricultural land as necessary.

6.2.2 Botanical Resources

The DW Project will affect several sensitive botanical resources. The California Natural Diversity Database identified one rare plant community, coastal and valley freshwater marsh, in close proximity to DW Project islands. Approximately 763 acres of habitat on the DW Project islands were delineated as jurisdictional wetlands under Section 404 of the Clean Water Act. The jurisdictional wetland verifications have expired, but DW Properties is currently working to update the delineation to reflect current conditions on the project islands. Based on extensive investigation, 14 special-status plants have been identified as potentially occurring in the area of the DW Project.

The environmental evaluation identified three main issues with respect to DW Project impacts on botanical resources. The issues are 1) the age of the botanical and wetland data used to determine project impacts, 2) a lack of surveys for the rare natural community coastal and valley freshwater marsh, and 3) a lack of thorough guidelines for weed management in the HMP developed for the DW Project. The majority of the botanical data used to assess the impacts of the DW Project are from 1988 and 1994. DW is currently redoing the wetland delineation in order to obtain a CWA Section 404 Permit from USACE. The delineation is scheduled for completion in summer of 2002. Impacts to jurisdictional wetlands were addressed in the HMP and would be mitigated on the habitat islands. The HMP does not outline specific mitigation or monitoring goals and guidelines for rare plant community impacts on the DW Project islands. However, Condition 12 of the DFG Incidental Take Permit addresses listed plants in the event that they are found prior to the implementation of the DW Project or become established during implementation of the HMP. If impacts to listed plant species are unavoidable, a mitigation and monitoring program will be implemented.

6.2.3 Aquatic Resources

Nine listed or sensitive fish species occur in the DW Project area and are likely to be affected by the project. The species include chinook salmon, delta smelt, splittail and Central Valley steelhead. The CESA Incidental Take Permit, USFWS and NMFS Biological Opinions, and the SWRCB Decision 1643 state that the DW Project has the potential to directly and indirectly impact listed fish species. In general, the impacts to fisheries could include:

- Increases in channel water temperature
- Reductions in channel water DO concentrations
- Changes in flow patterns
- Reduction in transport flows
- Increased entrainment of eggs and larvae
- Increases in total mercury or methyl mercury concentrations in water and biota due to reservoir and habitat island operations

The FOC based on USFWS, NMFS and DFG, were developed to ensure that project operations do not jeopardize the continued existence of delta smelt, splittail, chinook salmon and Central Valley steelhead. Other species are also expected to benefit from the FOC. As long as the DW Project operates to meet the FOC, impacts to listed fish species are considered less than significant.

However, the DW Project will likely result in impacts to listed fish species because of inadequate fish screens on intake pumps. The information available on the DW proposed fish screens indicate the following potential problems:

- The fish screens proposed by DW will not meet regulatory agency cleaning requirements
- The screen mesh size proposed by DW does not meet current requirements
- The proposed screen area does not meet the requirements for manually cleaned screens

A redesign of the DW fish screens or intake facilities will be necessary to ensure that project operations meet the restrictions in the FOC, biological opinions, and incidental take permit.

In addition, the FOC delta smelt diversion criteria may result in a reduction of project yield. Diversion criteria should be incorporated into model runs to fully assess the impacts to project operations.

6.2.4 Wildlife Resources

Diverse assemblages of wildlife species typical of the Sacramento-San Joaquin River Delta use the DW Project islands for foraging, roosting and breeding. The islands provide habitat to several special status species including the State threatened greater sandhill crane and Swainson's hawk. The project could affect over 180 species of birds, 30 species of mammals, and 10 species of reptiles and amphibians.

DW proposed to mitigate project impacts by developing and protecting 9,000 acres of wildlife habitat on two habitat islands, Holland Tract and Bouldin Island. A HMP was prepared to compensate for the loss of Swainson's hawk and greater sandhill crane foraging habitat, jurisdictional wetlands and wintering waterfowl habitat. The habitats that would be developed on the habitat islands include: agriculture crops, seasonal managed wetlands, pasture, emergent marsh, riparian, etc. Island management would not be optimized for agricultural production. Approximately 4,000 acres of crops would be planted but only 49% would be harvested.

If the DW Project becomes a public project, several issues should be addressed including incomplete ground surveys and a lack of a bat habitat evaluation on the project islands. In addition, the recreation proposed by DW will require continuous monitoring and analysis to ensure that it is compatible with species goals and objectives identified in the HMP.

6.2.5 Cultural Resources

A substantial amount of previous cultural resource compliance work has been conducted for the DW Project. The previous cultural resource studies were conducted from 1988 -1993 and were conducted in accordance with the requirements of Section 106 of the National Historic Preservation Act (NHPA). In addition, DWR and Reclamation staff conducted a field review of the project area in October 2001.

DW Properties identified sensitive cultural resources on all the project islands. Significant archaeological sites exist on Bouldin Island, Bacon Island, and Holland Tract. Areas of sensitive soils potentially containing prehistoric human remains exist on Webb Tract and Holland Tract.

To ensure compliance with NHPA and CEQA, additional steps should be taken to minimize and mitigate impacts to cultural resources. The steps include re-initiating Section 106 consultations, updating the Programmatic Agreement, re-surveying piper soils, conducting data recovery excavations, etc.

6.2.6 Hazardous Materials

The DWR Site Assessment Unit performed a modified Phase I Environmental Site Assessment of the DW Project islands. The modified assessments indicate that environmental conditions on Bouldin Island, Holland Tract, Webb Tract, and Bacon Island will require remediation before they can be used for either reservoir storage or habitat mitigation.

Site Assessment staff observed six general areas of concern that should be addressed prior to the acquisition and/or use of the project islands: chemical containers, stained soil, pesticide use, wells, structures and debris.

A Phase II Environmental Site Assessment should be completed for all islands prior to purchase to determine the extent that conditions on the islands require remediation, the costs for clean up, and any limits on the ability to use them as reservoir storage or habitat mitigation. The Phase II Environmental Site Assessment will also establish state and federal liability for future cleanup and remediation.

6.2.7 Recreation

The DPC and Department of Boating and Waterways (DBW) reported that recreation opportunities in the Delta are limited because facilities are insufficient, access is limited, and the demand for parking, boat launch ramps, camp sites, and picnic areas exceeds supply. As part of the DW Project, DW Properties has proposed private recreation facilities on all four islands. The recreation facilities consist of living quarters, floating docks on interior and exterior of the islands, and a parking lot.

On the reservoir islands, private waterfowl and upland bird hunting is proposed during both shallow-water wetland conditions and water storage conditions. Spaced-blind and free-roam hunting zones would be designated on the habitat islands.

If the DW Project becomes a public project, the proposed recreational facilities may not be appropriate for a publicly owned and operated project. The recreation plan should be modified to provide recreational benefits to the general public through a range of recreation opportunities. In addition, the recreational facilities proposed by DW do not meet the unmet recreational needs of the Delta such as fishing piers, bicycle and hiking trails, and public access points.

6.3 Re-engineered Delta Wetlands Project

This section provides a summary of the existing resources and impacts on the DW Project islands in the areas of botanical resources, aquatic resources, wildlife resources, and recreation that may change under Re-engineered DW Project. The existing resources and impacts in land use, cultural resources and hazardous materials assessments will not differ from those discussed for the DW Project (Section 6.2).

To address the impacts to agricultural land from the DW Project, staff evaluated the feasibility of keeping Bouldin Island in agricultural production and placing all mitigation on Holland Tract. Through the analysis it became apparent that there is not enough land on Holland Tract to provide all the required mitigation. Because of the shortfall, staff proposed the addition of Sherman or Twitchell islands instead of Bouldin Island.

6.3.1 Land Use

If Bacon Island and Webb Tract are converted to reservoir islands and Holland Tract and Bouldin Island are used for mitigation, then the Re-engineered DW Project will result in the same significant adverse impacts to agricultural land as the DW Project. The project would convert prime agricultural land to nonagricultural uses (DW EIS, page 3I-16).

Several possible solutions to minimize the impacts to agricultural land were investigated. In the first option, Bouldin Island was designated for only agricultural production. All wildlife and botanical mitigation would occur on Holland Tract. Approximately 9,000 acres of prime agricultural land would be used for environmental mitigation rather than 15,000 acres. Unfortunately, this option would create a 5271 acre shortage in land for wildlife and wetland mitigation. Consequently, this option is not feasible.

The second option designates Bouldin Island for only agricultural production and Sherman or Twitchell Island would be used for wildlife and wetland mitigation in its place. Agricultural easements could also be included in this option to further minimize impacts to agricultural land. The use of Sherman or Twitchell islands should be investigated further to determine if it is feasible to incorporate either island as part of the project. Additional work in the next phase of the program will be necessary to fulfill the requirements of the Farmland Protection Policy Act, identify specific land use mitigation measures, develop a schedule for implementation, and resolve any remaining Williamson Act issues with the Department of Conservation.

6.3.2 Botanical Resources

The Re-engineered DW Project will affect similar botanical resources as in the DW Project (Section 6.2). No evaluations were done for impacts on in-channel islands due to flow and stage changes from the proposed diversions. Without the project, adjacent river/slough stage variations of more than 0.5 feet occur as a result of tides and diversions. An option within the Re-engineered DW Project is flattening the slough-side levee slopes to 4:1. No evaluations were done to assess impacts to botanical resources that may occur on the slough-side of the levees. Further evaluations of impacts are recommended.

6.3.3 Aquatic Resources

The Re-engineered DW Project would affect the same fish species as in the DW Project (Section 6.2). One difference between the DW Project and the Re-engineered DW Project is the proposed fish screens and intake/discharge facilities. Consolidated facilities with self-cleaning flat plate screen technologies appear to be a possible solution to the inadequacies in the DW Project screens. The consolidated facilities were designed for 0.2 fps flow velocity. Further evaluations of changes in channel stage, velocity and flow are recommended.

Impacts to shallow water habitat from proposed changes in the slough-side of the levee slopes will occur. Projects that remove or alter areas within the tidal fluctuation zone can be required to mitigate at a 3:1 ratio by USFWS and DFG. Consultation with DFG and USFWS will be needed to address this issue.

As mentioned in the land use section, Sherman or Twitchell islands have been proposed for wildlife and wetland mitigation instead of Bouldin Island. No impacts to fisheries are expected with this option.

Several stakeholders requested we evaluate the feasibility of using Sherman Island for reservoir storage. Using Sherman Island for reservoir storage could have both positive and negative impacts on fishery resources in the Delta.

6.3.4 Wildlife Resources

The Re-engineered DW Project will affect the same wildlife resources as in the DW Project (Section 6.2). The emergent marsh habitat on the in-channel islands and on slough-side levee slopes has the potential to provide habitat for sensitive wildlife species, such as, the giant garter snake, California black rail, tricolored blackbirds, and western pond turtles. The impacts to wildlife from construction and operation of the integrated facilities and from flattening the slough-side of the levee slopes are unknown. An impact analysis should be done to quantify the direct and cumulative impacts to wildlife species and habitats that would be associated with the integrated facilities and any levee slope changes.

6.3.5 Recreation

In the Re-engineered DW Project, changes have been proposed to the recreation plan to provide recreational opportunities to the general public and a greater range of experiences. DPC and DBW identified shortages in recreation in the Delta including: public restrooms, swimming beaches, fishing piers, other fishing access, bicycle trails, hiking trails, and hunting areas.

The habitat islands lend themselves to a wide variety of recreational uses. Hiking and biking trails are proposed for the levees and less-sensitive wildlife areas. Wildlife observation or birdwatching could be easily incorporated into the design. Additional facilities could include informational signage, photography blinds, restroom facilities, and an interpretative center. Interpretative center topics could include wildlife and Delta ecology, Delta cultural resources, Delta history, and water projects.

Shoreside fishing access could be accommodated on the habitat islands as well. Short-term boat docking for shoreline access could be included in the general design.

Public hunting is compatible with the habitat islands and could be managed to avoid conflict with non-consumptive recreation. The hunting program would be modeled after that used on existing State Wildlife Management Areas.

Water project operations substantially limit the habitat and attraction for wildlife on the reservoir islands. It is more likely the reservoir islands lend themselves to levee-bank fishing access and short-term boat docking facilities on the exterior sides of the levees.

6.4 Bacon Island and Victoria Island storage and connection to Clifton Court

No on site evaluations of Victoria Island were conducted. Victoria Island is privately owned and the landowners and Reclamation District did not grant access to the island. The impacts of converting Victoria Island will likely be similar to impacts discussed in the previous sections. Based on available information, staff concluded the following:

- All of Victoria Island is in agricultural production and approximately 5,000 acres are designated as prime agricultural land. Approximately 20,000 acres of prime farmland would be converted to nonagricultural uses under this alternative. This is a significant adverse impact on agricultural land.
- As in the Re-engineered DW Project, the impact of the integrated facilities on special-status plant populations and high-quality native wetland vegetation on in-channel islands is unknown.
- Converting Victoria Island to reservoir storage will negatively affect Swainson’s hawk foraging habitat. Approximately 4,948 acres of land on Victoria Island is considered suitable Swainson’s hawk foraging habitat. In addition, alfalfa, a crop with high foraging value to Swainson's hawks, is grown on Victoria Island and not Webb Tract. The Swainson’s hawk mitigation needed for this alternative would increase over levels needed for the DW Project.

A portion of Victoria Island was surveyed by Reclamation in 1994 and no cultural resources were identified during that survey effort. No sensitive areas, such as piper soils, exist on the island.

6.5 Mitigation Measures

A summary of the mitigation measures and costs estimated for the DW Project is given in Tables 13 and 14.

Table 13
ESTIMATED INITIAL ENVIRONMENTAL MITIGATION AND MONITORING COSTS FOR THE DW PROJECT

Mitigation and Monitoring	Initial Costs
Habitat island development and construction	$21,220,000
Project construction monitoring	$ 400,000
Fisheries mitigation[a]	$ 2,300,000
Cultural resources mitigation	$ 945,000
DW proposed recreation if built by public agency	$584,000,000
Phase II Environmental Site Assessment	$135,000
Total initial costs	$609,000,000
[a]Fisheries mitigation costs are driven DFG's COA 5.5 assumed maximum "Net Environmental Water" of 20,000 AF in any water year. About $55 per acre foot diverted is provided to DFG. The "Net Environmental Water" should not be confused with EWA. The two are not the same.	

Table 14
ESTIMATED ANNUAL ON-GOING COSTS FOR ENVIRONMENTAL MITIGATION, MONITORING AND WEED CONTROL FOR THE DW PROJECT

Mitigation and Monitoring	Annual Costs
Habitat island monitoring and operations and maintenance	$1,400,000
Fisheries mitigation and monitoring	$ 2,800,000
Fish screen operation and maintenance	$2,200,000
Cultural resources mitigation	$ 10,000
Invasive weed control on reservoir islands	$722,016
DW proposed recreation[a]	unknown
Total annual costs	> $7,132,016
[a]Assumes public ownership and private management	

The mitigation and monitoring costs associated with the Re-engineered DW Project will likely be similar to the DW Project. The following differences may occur:

- Costs for agricultural easements or other land use mitigation are unknown
- Costs for flat-plate screen operation and maintenance are assumed to be lower than DW Project
- Costs for invasive aquatic weed control on the reservoir islands will increase to $930,000 per year with periodic maintenance of weed barriers at $400,000 every ten years
- If the option to flatten the slough-side levee slopes is pursued, mitigation costs for removal of shallow water habitat and other sensitive resources are unknown
- Costs for the revised recreation plan are $3.2 million for initial construction and $265,000 for annual operation and maintenance. This could result in a reduction in environmental mitigation costs of over $500 million

The mitigation and monitoring costs associated with the Bacon Island and Victoria Island storage and connection to Clifton Court alternative will also differ from the DW Project in the following ways:

- Costs for agricultural easements or other land use mitigation are not included
- Costs for flat-plate screen operation and maintenance are assumed to be lower than DW Project
- Costs for initial cultural resources mitigation will increase to $960,000

- Costs for revised recreation plan including Victoria Island are $3.6 million for initial construction and $280,000 for annual operation and maintenance

6.6 Recommendations

- The DW project should be evaluated for consistency with the Farmland Protection Policy Act and modified to minimize the impacts from loss of agricultural lands as necessary.
- Environmental Site Assessment should be completed to establish state and federal liability for future cleanup and remediation.
- Botanical and wildlife surveys should be conducted to gather data necessary for Action Specific Implementation Plans and future CEQA/NEPA documents required for either the Re-engineered DW Project, the Bacon Island and Victoria Island storage and connection to Clifton Court alternative, or other reconfigurations.
- Alternative fish screens should be evaluated to reduce aquatic impacts in streams adjacent to the reservoir islands and to comply with the 2000 DFG Fish Screening Criteria.

Chapter 7
ECONOMIC ANALYSIS

7.1 General

Two types of economic analysis were done for this study. First, benefit and cost information was developed to evaluate the economic justification for the proposed project. Second, a project area economic impact analysis was made to disclose the potential for both positive and negative impacts to the economy of the local area. While the former analysis is traditionally done using only direct costs and benefits, the later analysis considers indirect and induced local economic effects — the ripple effects.

The use of direct benefits and costs for economic justification avoids the difficulty of developing indirect and induced effects for, in this case, the areas benefiting from the additional water supply reliability provided by the proposed project. The assumption is made that if the direct benefits exceed the direct costs, there is a net gain when all of the indirect and induced effects throughout the State are taken into account. Further details are presented in a separate report, “In-Delta Storage Program Draft Report on Economic Analysis,” May 2002.

7.2 Benefits and Costs

Economic analysis is based on evaluation of Equivalent Annual Cost of project implementation including costs of project development, construction, mitigation and operation and maintenance, and the benefits as a result of increased project exports, operational flexibility, CVPIA(b)(2), Environmental Water and potential for water transfers.

Unit water supply costs simply compare the equivalent annual project cost to the average annual water supply benefit on a dollars per acre-foot basis. This assessment should not be construed as the cost per acre-foot of water supply. Instead, this economic evaluation should be considered one of many feasibility indicators that must be taken into consideration for project screening.

To estimate the urban and agricultural water supply economic benefits two models were used. An urban economic evaluation was performed using the Least-Cost Planning Simulation Model (LCPSIM) while the agricultural evaluation was preformed using the Central Valley Production Model (CVPM). The economic assumptions, evaluation methodologies, and study results are discussed in this chapter.

7.2.1 Project Capital Cost

Project Capital Cost includes the following.

- Total Construction Cost including engineering design, legal and construction as given in Table 10 in Chapter 5.
- Regulatory costs
- Forgone Investment Value

Capital Project Cost including the Construction Cost, Regulatory Cost and Foregone Investment Value are given in Table 17. The procedure used in estimation of Regulatory Cost and Foregone Investment Value is discussed in Sections 7.2.1.1 and 7.2.1.2.

7.2.1.1 Regulatory Costs

Regulatory costs reflect documentation, permitting and initial monitoring and mitigation expenses. Estimated initial environmental mitigation and monitoring costs are given in Table 15.

7.2.1.2 Forgone Investment Value

The Foregone Investment Value was calculated based on the construction estimate, engineering and regulatory costs. The Forgone Investment Value sometimes referred to as Interest During Construction, is typically considered in estimating the total capital cost of a proposed project. Throughout the construction period, funds are withdrawn from the economy to support the construction process. These allocated funds are therefore not available during the construction period for alternative investment opportunities that would provide net economic returns. A discount rate of 6% was assumed for this adjustment.

A construction period of five years was assumed for the project. For Cost Allocation purposes, cost of proposed storage facilities construction is assumed as follows.

Year 1: Land Acquisition Cost plus 15% Conveyance Facilities and Levee Improvements Costs
Year 2: 20% Conveyance Facilities and Levee Improvement Costs
Year 3: 25% Conveyance Facilities and Levee Improvement Costs
Year 4: 20% Conveyance Facilities and Levee Improvement Costs
Year 5: 20% Conveyance Facilities and Levee Improvement Costs

Forgone Investment Values are shown below in Table 16.

Table 15
REGULATORY COSTS

Alternative	Mitigation, Monitoring & Regulatory Costs
Re-Engineered Delta Wetlands	$21,000,000
Bacon Island and Victoria Island with connection to Clifton Court	$21,000,000
Webb Tract and Victoria Island with connection to Clifton	$21,000,000

Table 16
FORGONE INVESTMENT VALUE ADJUSTMENT
(Millions of 2001 Dollars)

Alternative	Project Total Construction Costs	Years to Construct	Adjustment (Year 4)	Adjustment (Year 3)	Adjustment (Year 2)	Adjustment (Year 1)	Adjustment (Year 0)	Total Adjustment
Re-Engineered Delta Wetlands	423.9	5	32.4	16.2	13.1	5.1	--	66.8
Bacon and Victoria Island with connection to Clifton Court	510.2	5	37.2	19.5	15.8	6.1	--	78.5
Webb Tract and Victoria Island with connection to Clifton Court	501.3	5	36.7	19.1	15.5	6.0	--	77.4

7.2.2 Annual Cost Development

The annual cost is the sum of the three elements: (1) the capital recovery cost, (2) property tax loss in-lieu property tax payments for loss of agriculture, and (3) the recurring annual costs. The first element includes the amortized total capital cost. The second element includes the loss of revenues due to loss of agricultural lands and in-lieu payment. The third element includes operation and maintenance costs as well as energy costs incurred for the project operations.

- Capital Recovery - Annualized capital costs were developed for each of the proposed projects. This is based on the total capital costs amortized over a 50-year period with an assumed discount rate of 6%.
- In-lieu property tax payments
- Recurring Annual Operation and Maintenance Costs: These costs include the following items.
  - Levee maintenance
  - Intake and outlet structures maintenance including pumping stations, gate units, siphons and fish screens for both, reservoir and habitat islands.
  - Pumping energy costs
  - Seepage control systems maintenance and monitoring
  - Water quality monitoring, and
  - Environmental monitoring including wildlife and habitat monitoring.

Annual Cost of Development for in-Delta storage alternatives is given in Table 17.

Table 17
TOTAL CAPITAL AND EQUIVALENT ANNUAL COST DEVELOPMENT FOR IN-DELTA STORAGE
(Millions of 2001 dollars)

Alternative	Base Construction Estimate	Mitigation Monitoring & Regulatory Costs	Project Total Construction Cost	Mobilization Cost	Contingency Cost	Engineering, Legal & Admin Cost	Total Project Cost	Forgone Investment Adjustment	TOTAL CAPITAL COST	Annual Capital Cost	Annual O&M Cost	EQUIVALENT ANNUAL COST	UNIT COST [a] $/Acre-ft
A	B	C	D	E	F	G	H	I	J	K	L	M	N
			B + C	.05 x D	0.2 x D	.25(F+D+E)	D+E+F+G		H+I			K+L	
Re-Engineered Delta Wetlands	402.9	21.0	423.9	21.2	84.8	132.5	662.4	66.8	729.1	46.3	8.3	54.6	430
Bacon Island and Victoria Island with connection to Clifton Court	489.2	21.0	510.2	25.5	102.0	159.4	797.2	78.5	875.7	55.6	8.4	63.9	511
Webb Tract and Victoria Island with connection to Clifton Court	480.3	21.0	501.3	25.1	100.3	156.6	783.2	77.4	860.6	54.6	8.3	62.9	503

[a]Assumes 127 TAF/yr based on operation studies. The unit cost may be even higher with lower yield to fully comply with the delta smelt and DOC criteria.

7.2.3 Assessment of Project Benefits

7.2.3.1 General

Project benefits to be included in economic evaluation are:

- Additional SWP/CVP system exports for urban and agricultural use

- Contribution to meet CVPIA requirements including South of Delta refuges
- Additional joint point diversion benefits
- EWA
- Banking for water transfers
- Recreational benefits

7.2.3.2 Urban and Agricultural Water Supply Benefits

To estimate the urban and agricultural water supply economic benefits two models will be used. An urban economic evaluation is to be performed using the DWR's LCPSIM while the agricultural benefits will be evaluated with the CVPM. The economic assumptions for these models are as follows.

7.2.3.2.1 Urban Benefits LCPSIM

- Benefits in relation to base deliveries include 2020 impacts on shortage related costs and losses and on the economic justification for adding additional local reliability from the available water use efficiency options (e.g., water recycling.) The benefits of any alternative are determined by the change in total avoided costs and losses: shortage-related and related to the use of local water use efficiency options.
- The conservation options used in LCPSIM are beyond those expected to be implemented by 2020 under the urban Best Management Practices MOU.
- Regionally, the San Francisco Bay Region is expected to be at a relatively high level of reliability in 2020 after the assumed adoption of economically justified local water conservation and supply augmentation measures in context of the assumed availability of local carryover storage. Consequently, SWP deliveries available under contract and interruptible deliveries that were not of net economic value to the region (hereafter referred to as unallocated deliveries) were assumed to be available to augment SWP South Coast Region urban deliveries.
- Because of the level of local reliability that will be justified in 2020 within the region and the assumed availability of local carryover storage, the unallocated San Francisco Bay Region deliveries, SWP supplies available under contract, and interruptible supplies not of net economic value to the South Coast Region were assumed to augment SWP agricultural deliveries. The incremental unallocated deliveries produced by the project were assumed to augment CVP agricultural deliveries.
- Unallocated deliveries for SWP urban use generated by the project can be retained for CVPIA refuges water or can be credited to CVP for agricultural uses. For this study, the deliveries were credited to CVP agricultural users. This logic is meant to model one potential outcome of market based future water allocation negotiations between urban and agricultural users (in this case, an unconstrained "free-market" bookend.)
- Although the implementation of urban water conservation measures reduce the frequency and magnitude of shortages, demand hardening effects are assumed to cause an increase in economic losses when water shortages do occur. Since the already implemented conservation measures (assumed to be less costly than the remaining conservation options) are no longer available for shortage management, the value of new supply is therefore increased during shortage events.
- Reliability benefits for the Central Coast Region, an area not covered by the LCPSIM model, was interpolated from the results produced by LCPSIM for the San Francisco Bay Region.
- Benefits of the project to urban users of SWP supplies in the San Joaquin Valley were based on the cost of existing local groundwater operations.

Shown in Table 18 and Table 19 are the results of the LCPSIM analysis for the San Francisco and South Coast Regions, respectively.

Table 18
SUMMARY OF RESULTS FOR THE SAN FRANCISCO BAY REGION (2001 dollars)

Regional Economic Benefits		**Value**
Avg Incremental Available Uran Supply (TAF)		8
Avg Incremental Unallocated Urban Supply (TAF)		1
Net Avg Incremental Delivered Urban Supply (TAF)		7
Avoided Costs/Losses ($1,000)		$4,992
Avg Value of Incremental Urban Supply ($/AF)		$699
Regional Water Management – Least-Cost Planning Criterion		
	Without Project	Change from Without Project (Costs/Losses are Annual Values)
Expected Shortage-Related Costs/Losses ($1,000)	$91,040	-$548
Shortage Contingency Water Transfers		Change from Without Project (Costs and Quantities are for the 73-Year study period)
Number of Transfer Events	8	0
Total Quantity Transferred (TAF)	520	-2
Total Cost ($1,000)	$95,004	-$365
Avg Quantity per Transfer Event	65	0
Water Supply/Water Use Efficiency Option Use		Change from Without Project (Costs and Quantities are Annual Values)
Conservation (TAF)	65	-3
Conservation Cost ($1,000)	$27,996	-$2,313
Groundwater Recovery (TAF)	9	0
Groundwater Recovery Cost ($1,000)	$4,792	$0
Recycling (TAF)	28	-3
Recycling Cost ($1,000)	$5,662	-$2,061
Seawater Desalting (TAF)	0	0
Seawater Desalting Cost ($1,000)	$0	$0
Total Option Use (TAF)	102	-6
Total Option Cost ($1,000)	$38,450	-$4,374

Table 19
SUMMARY OF RESULTS FOR THE SOUTH COAST REGION (2001 DOLLARS)

Regional Economic Benefits		**Value**
Avg Incremental Available Urban Supply (TAF)		60
Avg Incremental Unallocated Urban Supply (TAF)		24
Net Avg Incremental Delivered Urban Supply (TAF)		36
Avoided Costs/Losses ($1,000)		$25,475
Avg Value of Incremental Urban Supply ($/AF)		$709
Regional Water Management – Least-Cost Planning Criterion		
	Without Project	Change from Without Project (Costs/Losses are Annual Values)
Expected Shortage-Related Costs/Losses ($1,000)	$267,508	-$2,094
Shortage Contingency Water Transfers		Change from Without Project (Costs and Quantities are for the 73-Year study period)
Number of Transfer Events	7	0
Total Quantity Transferred (TAF)	617	-23
Total Cost ($1,000)	$112,726	-$4,202
Avg Quantity per Transfer Event	88	-3
Water Supply/Water Use Efficiency Option Use		Change from Without Project (Costs and Quantities are Annual Values)
Conservation (TAF)	307	-16
Conservation Cost ($1,000)	$153,520	-$13,154
Groundwater Recovery (TAF)	93	-5
Groundwater Recovery Cost ($1,000)	$52,799	$3,422
Recycling (TAF)	351	-9
Recycling Cost ($1,000)	$145,042	-$6,804
Seawater Desalting (TAF)	0	0
Seawater Desalting Cost ($1,000)	$0	$0
Total Option Use (TAF)	751	-30
Total Option Cost ($1,000)	$351,360	-$23,381

7.2.3.2.2 Agricultural Benefits CVPM

- Both short-run and long run responses to changes in water resource conditions will be evaluated. The purpose of the long-run analysis is to estimate average economic conditions after farmers have made long-term adjustments to changes in supply availability and economic conditions. The purpose of the short-run analysis is to estimate acreage, crop mix, and water use during above and below average hydrologic events, given farmers' best possible responses to the temporary situation.
- The potential sources for agricultural water in each region are identified as CVP water service contract supply, CVP water rights and exchange supply, SWP supply, local surface supply, and groundwater.
- In the base case (i.e., no action alternative), unallocated interruptible and unallocated contract SWP urban deliveries are allocated to San Joaquin Valley SWP and CVP agricultural contractors in proportion to their deliveries under their respective contracts.
- The additional unallocated interruptible and unallocated contract SWP urban deliveries produced by the project are used to augment CVP agricultural deliveries.
- To reflect the reasonable (and conservative) assumption that planted acreage would not be based on interruptible deliveries because of planting decision constraints, planted acreage is held to the amounts which resulted from the evaluation of contract deliveries. In this manner, only reductions in local agricultural ground water pumping costs due to the in-lieu surface supply would be the benefit of the interruptible deliveries.

Table 20
AGRICULTURAL WATER SUPPLY BENEFITS

Supply Category	SWP (TAF)	CVP (TAF)	Total (TAF)	Value ($1,000)
Base Allocation				
Contract Deliveries	28	3	31	$2,106
Interruptible Deliveries	13	0	13	$682
Incremental Allocation				
Contract Deliveries	0	24	24	$1,750
Interruptible Deliveries	0	1	1	$97
Subtotal				
Contract Deliveries	28	27	55	$3,856
Interruptible Deliveries	13	1	14	$779
Total	41	28	69	$4,635

Shown in Table 20 are the agricultural water supply benefits broken out into two categories, a base allocation of all unallocated SWP urban deliveries in the base case are to SWP and CVP agricultural users in proportion to their existing contracts in the San Joaquin Valley and an incremental allocation of the supply provided by in-Delta storage will be allocated to the CVP agricultural users.

The LCPSIM analysis allows for market transfers of water from the agricultural sector to the SF Bay and South Coast Regions during serious shortage events. These transfers, which are constrained to mitigate third-party impacts, are taken into account buy reducing the supply available to agricultural users in the San Joaquin Valley during those events. These transactions are assumed to be between willing buyers and willing sellers.

7.2.3.3 Contribution to CVPIA(b)(2)

- The net benefits to CVPIA will be determined from the reduction in South of the Delta SWP and CVP exports due to implementation of the CVPIA requirements.

- CVPIA water banking will be considered as a benefit to the CVP.

- Any re-allocated water from urban sector can be given credit as the CVPIA water. For example, supplies turned back from SWP MWD use can be transferred to CVPIA Refuges.

7.2.3.4 Environmental Water Benefits

- 10% of exports to be released as environmental water from DW Project as per Biological Opinion.
- The net benefit of EW will be based on any potential benefits in addition to CVPIA and exports.

7.2.3.5 Banking for Water Transfers

- Economic value of interim banking for water transfers in in-Delta storage will be evaluated on qualitative basis.

7.2.3.6 Recreational Benefits

- Reservoir and Habitat Islands recreational benefits will be based on public ownership and State and Federal operations of recreational facilities.

7.2.3.7 Avoided Levee Maintenance Cost

- The current levee maintenance regime will be replaced by the maintenance included in the cost of in-Delta storage.

A summary of all the benefits evaluated is presented in Table 21.

Table 21
SUMMARY OF ANNUAL BENEFITS

Benefit Category	SWP (TAF)	CVP (TAF)	Total (TAF)	Value ($1,000)
Agricultural				
Supply	41	28	69	$4,635
Water Market Transfers				
SF Bay Region[1]				-$5
South Coast Region[1]				-$62
Total	41	28	69	$4,568
M&I Supply				
SF Bay Region	7		7	$4,922
South Coast Region	36		36	$24,475
Central Coast Region	2		2	$1,106
San Joaquin Valley	4		4	$405
Total	49		49	$30,908
Environmental			12	$1,549
Total Supply Benefits	90	28	130	$37,025
Recreation				
Alt 2				$674
Alt 3				$771
Avoided Levee Maintenance Cost				
Alt 2				$700
Alt 3				$919
Total Benefits				
Alt 2				$38,399
Alt 3				$38,715
[1]Average annual quantities are much less than 1,000 AF.				

7.3 Delta Economic Impacts

The economic impact analysis was designed to identify potential gains and losses to the area local to the proposed project stemming from changes in the economy of the area due to the existence of the project. For this purpose, Input-Output models designed to identify economic linkages in the local economy were employed. These linkages exist because a change in the level of any economic activity in one sector of the economy affects the level of activity of those sectors of the economy which provide it with goods and services. Farmers, for example, depend on the output of tractor manufacturers and dealers and, depending upon the crop, custom services for harvesting. Those providing custom services for harvesting, in turn, depend upon the output of harvest equipment manufacturers, equipment repair services, and fuel suppliers and so on.

The effects generated by the Input-Output models are classified as direct (e.g., cut in farm production), indirect (e.g., reduced need for custom harvesting services), and induced. The induced effects arise from the change in income due to the direct and indirect effects. This income change affects the overall level of consumption of goods and services.

For the purposes of the impact analysis, the linkages are evaluated only in so far as they affect local economic activity. The impact on equipment manufacturers in other parts of California or other states is not included, for example. Also outside of the scope of this impact analysis are the same types of economic effects, which occur in the areas benefiting from the additional water supply reliability provided by the proposed project.

Changes in local economic activity evaluated in this section arise from:

- Loss of crop production.
- Operations and maintenance of the proposed project facilities (including recreation facilities).
- Additional recreation days produced by the proposed project.

The impact numbers generated for these evaluations represent the sum of the direct, indirect, and induced economic effects and were developed using a MIG IMPLAN model set up for Contra Costa and San Joaquin counties. The income effects shown are for employee compensation and proprietor’s income effects only.

7.3.1 Loss of Crop Production

Table 22 shows the value of existing agricultural production and Table 23 shows the local employment and income impacts of the loss of that production on each of the affected Delta islands, depending upon the alternative selected, as a consequence of the proposed project.

This production loss scenario probably overstates the size of the actual impacts, however. If the asparagus crop production lost, for example, is moved to another Delta island, the net impact would depend on the crop type it replaces in the other location. Because the replaced crop is likely to have lower associated impacts, the net impact is likely to be lower. If field corn elsewhere in the local area is replaced by the asparagus no longer grown on Bouldin Island, for example, the per-acre employment impact will be about four times lower and the income impact will be about six times lower. The migration of asparagus is problematic because the increased foreign competition for that crop may make the investment needed to produce that crop elsewhere in the area impractical.

What is not taken into account, however, is the effect of the loss of crop production on those activities related to the hauling, storage, and processing of the crops produced after they leave the farm. To the extent that these activities take place in the local area, or to extent that local hauling companies, storage facilities, and processors cannot substitute other crops, this represents a loss not captured in this evaluation.

Table 22
ESTIMATED VALUE OF PRODUCTION OF CROPS GROWN ON DW ISLANDS
(Indexed 1997 prices[3] and 1997 yields[2])

Crops	Webb Tract		Holland Tract		Bouldin Island		Bacon Island		Victoria Island		All Islands	
	Acres[1]	Value of Production ($1,000)	Acres[1]	Value of Production ($1,000)[4]	Acres[1]	Value of Production ($1,000)	Acres[1]	Value of Production ($1,000)	Acres[1]	Value of Production ($1,000)	Acres[1]	Value of Production ($1,000)
Alfalfa									1,038	$995	1,038	$995
Asparagus							290	$895	2,204	$6,799	2,494	$7,694
Corn (field)	2,742	$1,361	514	$255	3,519	$2,387	2,206	$1,496	847	$575	9.828	$6,075
Grain sorghum							71	$26			71	$26
Potatoes							830	$3,014			830	$3,014
Safflower			991	$385					1,983	$1,071	2,974	$1,456
Small grains	1,921	$444	1,253	$290	1833	$728	851	$338	720	$286	6,578	$2,085
Sunflowers							888	$448			888	$448
Vegetables							3	$14			3	$14
Total	4,663	$1,805	2,758	$929	5,352	$3,115	5,139	$6,231	6,792	$9,726	24,704	$21,806

[1]Acreages are from 1995 Contra Costa County Land Use Survey and 1996 San Joaquin County Land Use Survey.
[2]Yield per acre are from 1997 Contra Costa County Crops Reports and 1997 San Joaquin County Crop Reports.
[3]Prices and values of production are indexed to the 2001 level from 1997 dollars.
[4]Value of production on Holland Tract does not include production from 1,120 privately-owned acres.

Table 23
LOCAL EMPLOYMENT AND INCOME EFFECTS FROM LOSS OF AGRICULTURAL PRODUCTION

		Alfalfa	Asparagus	Corn (field)	Grain sorghum	Potatoes	Safflower	Small grains	Sunflowers	Vegetables	Total
Webb Tract	Employment			38				17			55
	Income ($1,00)			$914				$370			$1,284
Holland Tract	Employment			7			13	11			31
	Income ($1,00)			$171			$301	$241			$713
Bouldin Island	Employment			66				29			95
	Income ($1,00)			$1,603				$606			$2,209
Bacon Island	Employment		21	42	1	71		13	15	0	163
	Income ($1,00)		$692	$1,005	$18	$2,330		$281	$350	$11	$4,686
Alt 1, 2	Employment		21	153	1	71	13	71	15		345
	Income ($1,00)		$692	$3,694	$18	$2,330	$301	$1,498	$350	$11	$8,893
Victoria Island	Employment	67	160	16			36	11			290
	Income ($1,00)	$1,254	$5,255	$386			$837	$238			$7,971
Alt 3	Employment	67	182	169	1	71	49	82	15	0	636
	Income ($1,00)	$1,254	$5,947	$4,080	$18	$2,330	$1,138	$1,736	$350	$11	$16,863

7.3.2 Gains from Operations and Maintenance of the Proposed Project Facilities

Operation and maintenance expenditures for the water supply and recreation facilities will have a positive effect on local employment and income. Table 24 shows the indirect, and induced economic gains for each alternative. The recreation plans recommended by CH2MHill for Alternatives 1, 2 & 3 are assumed to be implemented.

Table 24
LOCAL EMPLOYMENT AND EMPLOYEE AND PROPRIETOR INCOME EFFECTS FROM OPERATION AND MAINTENANCE EXPENDITURES

Expenditure Category	Expenditures ($1000)			Total Employment Generated			Total Income Generated ($1000)		
	Alt 1	Alt 2	Alt 3	Alt 1	Alt 2	Alt 3	Alt 1	Alt 2	Alt 3
Maintenance	$5,774	$4,325	$4,389	156	117	119	$6,172	$4,624	$4,691
Energy	$870	$960	$894	2	3	3	$182	$201	$187
Operating Staff Compensation	$1,010	$610	$610	20	13	13	$1,562	$944	$944
Total	$7,654	$5,896	$5,893	179	132	134	$7,917	$5,768	$5,822

7.3.3 Additional Recreation Gains

7.3.3.1 Review of DW Project Proposed Recreation Days

Table 25 shows the estimated number of recreation use days that currently exist on the DW project islands. Hunting is private except for for-fee use on Holland Tract. Except for Holland Tract, fishing on the other islands occurs on the levees and is private. Two marinas exist on Holland Tract and account for the high numbers of boaters using the island.

Table 26 shows the estimated number of recreation use days that could be expected with the DW Project as proposed and estimated by JSA (1995). The proposed DW recreation plan will increase the number of private hunting, fishing and other use days on the project islands.

The cost of the DW proposed recreation has been estimated at over $583 million. The proposed recreation is expected to create 80 permanent full time equivalent jobs and 13 secondary jobs in the regional economy. JSA (1995) estimated that nonlocal recreationists would spend $3.1 million annually. As mentioned in Section 6.0, the plan does not meet the unmet recreational needs of the Delta including fishing piers, bicycle and hiking trails, and public access points. The recreation proposed by DW is not appropriate for a public project because the benefits of the facilities are limited to private uses and the cost to construct is high.

Table 25
ESTIMATED RECREATION USE DAYS ON ALL FOUR ISLANDS AS OF 1995

Island	Hunting (Use Days)	Fishing/Boating (Use Days)
Bacon Island	100	3120
Webb Tract	640	90
Bouldin Island	210	360
Holland Tract	60	57,050
Total	1,010	60,620
source: JSA 1995		

Table 26
ESTIMATED RECREATION USE DAYS ON ALL FOUR ISLANDS UNDER THE DW PROPOSED RECREATION PLAN

Island	Hunting (Use Days)	Fishing/Boating (Use Days)	Other (Use Days)
Bacon Island	2591	14,589	11,137
Webb Tract	2664	14,589	11,137
Bouldin Island	8632	13,290	10,157
Holland Tract	4011	36,078	6,098
Total	17,898	78,546	38,530
source: JSA 1995			

7.3.3.2 Recreation proposed for Re-engineered DW Project

Section 6.0 describes the recreation proposed under the Re-engineered DW Project. Table 27 shows the estimated number of recreation use days that could be expected with the Re-engineered DW Project.

The proposed recreation plan will increase the number of hunting, fishing, hiking, biking, and interpretative experiences currently available. In addition, all the facilities would be public rather than private.

Table 27
ESTIMATED RECREATION USE DAYS ON ALL FOUR ISLANDS UNDER THE RE-ENGINEERED DW PROJECT

	Hunting (Use Days)	Fishing/Boating (Use Days)	Other (Use Days)
All Islands	9,019	195,840	33,000

It is likely that the proposed hunting will create new hunting opportunities for the public. The fishing, boating, hiking, biking, wildlife observation and use of the interpretative center will only generate 10-20% new users (Section 7.3.3.4).

The cost of the proposed recreation is estimated at $3.2 million. The recreation will likely generate 36 FTE jobs and nonlocal recreationists will spend $887 thousand annually (Table 29).

7.3.3.3 Recreation proposed for Victoria and Bacon Reservoirs and connection to Clifton Court

The recreation proposed under the Bacon and Victoria islands storage option is very similar to the Re-engineered DW Project. The plan assumes that recreation will continue on the habitat islands and on Bacon Island as proposed under the Re-engineered DW Project. The number of levee fishing access sites on Victoria Island would be increased and a levee-based hiking/biking trail could be located on each half of the island as loop trails. Table 28 shows the estimated number of recreation use days that could be expected with the Bacon Island and Victoria Island storage option.

Table 28
ESTIMATED RECREATION DAYS FOR VICTORIA/BACON STORAGE OPTION

	Hunting (Use Days)	Fishing/Boating (Use Days)	Other (Use Days)
All Islands	9,019	244,800	36,000

The proposed hunting will create new hunting opportunities for the public as in the Re-engineered DW Project. The fishing, boating, hiking, biking, wildlife observation and use of the interpretative center will only generate 10-20% new users (Section 7.3.3.4).

The cost of the proposed recreation is estimated at $3.6 million. The recreation will likely generate 42 FTE jobs and nonlocal recreationists will generate $1.03 million annually (Table 29).

7.3.3.4 Recreation Gains Produced by In-Delta Storage Alternatives

The additional days of recreation generated by the proposed project will also have a positive effect on local employment and income. This arises from expenditures by recreationists in the local area. Table 29 shows the indirect, and induced economic recreational gains for each alternative. It was assumed for this study that the hunting days induced by the public hunting opportunity provided by the proposed project will be new days except for those currently occurring on the islands. New days are those which are not defined by visits, which would have been made elsewhere in the local area, or just represent an enhanced experience for visitors who would be in the same location anyway. In both of these cases, additional local expenditures are not generated.

In contrast, it was assumed that only 20% of the days generated by fishing, hiking and biking, and wildlife interpretation will be new days and only 10% of the boating days were assumed to be new. It was also assumed that trip expenditures within the Delta area and, therefore, affecting the local economy, were about one-half of the total trip expenditures. Not counted were expenditures outside the Delta but in nearby areas that would still be of significant benefit to the local economy.

Visitor days were obtained from the November 2001 Recreational Options Technical Memorandum prepared by CH2MHill. California expenditure numbers were adopted from the 1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation report done by the U.S. Department of the Interior. The percentage of expenditures made within the Delta was developed from information in the 1995 Sacramento-San Joaquin Delta Recreation Survey done for the California Department**.**

Table 29
LOCAL EMPLOYMENT AND EMPLOYEE AND PROPRIETOR EFFECTS OF RECREATION EXPENDITURES

		Hunting	Fishing	Hiking/Biking	Interpretation	Boat Visit Days	Total
Visitor Days[1]	Alt 1 & 2	9,019	9,600	3,000	30,000	186,240	237,859
	Alt 3	9,019	12,000	6,000	30,000	232,800	289,819
Unit Daily Exp[2]		$40.40	$42.60	$40.40	$40.40	$40.40	
New User Factor	Alt 1 & 2	89%	20%	20%	20%	10%	
	Alt 3	88%	20%	20%	20%	10%	
In-Delta Expenditure Factor[3]		50%	50%	50%	50%	50%	
Total Expenditures ($1000)	Alt 1 & 2	$162	$41	$12	$121	$376	$712
	Alt 3	$160	$51	$24	$121	$470	$827
Total Employment Generated	Alt 1 & 2	8	2	1	6	19	36
	Alt 3	8	3	1	6	24	42
Total Income Generated ($1000)	Alt 1 & 2	$201	$51	$15	$151	$468	$887
	Alt 3	$199	$64	$30	$151	$585	$1,029

[1]Based on CH2M Hill Recreational Options Technical Memo (Nov. 30, 2001)
[2]Based on 1996 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (U.S. Department of the Interior)
[3]Estimated from Sacramento-San Joaquin Delta Recreation Survey (1995)

7.3.4 Net Local Employment and Income Effects

Table 30 shows the net effect on the local economy of the loss of agricultural production on the affected islands, the additional recreation expected from the proposed project, and the operations and maintenance activities which will be required to operate the water supply facilities as well as the recreation facilities. Included are the losses due to current levee maintenance activities. As shown in Table 30, in case of the Victoria Island (Alternative 3), adverse impact on agriculture is high. The DW Project will have minimal adverse impact because agricultural losses are offset by increased recreation and maintenance jobs and income.

Table 30
NET LOCAL EMPLOYMENT AND EMPLOYEE AND PROPRIETOR INCOME EFFECTS

Effect Category	Employment			Income ($1000)		
	Alt 1	Alt 2	Alt 3	Alt 1	Alt 2	Alt 3
Agricultural	-345	-345	-636	-$8,893	-$8,893	-$16,863
Current Levee Maintenance	-19	-19	-25	-$749	-$749	-$983
Recreation	36	36	42	$887	$887	$1,029
Operations and Maintenance	179	132	134	$7,917	$5,768	$5,822
Net Effect	-149	-196	-485	-$838	-$2,987	-$10,995

7.4 Summary

Economic analyses provided a partial assessment of benefits resulting from incremental water supplies. At this stage of the analysis allocations for various uses are not known. No attempt was made to present the economic benefits and development cost in terms of a benefit/cost ratio and results of this partial economic analysis should not be perceived as indicators of financial feasibility of the project. In addition to quantitative assessment of incremental water supply and economic impact of the project, environmental, CVPIA, banking and transfers and, recreation benefits have been explained qualitatively in various sections of the Economic Analyses Chapter. Further studies are recommended for complete quantitative assessment of the following benefits.

Environmental Water Use: Although it was possible to evaluate mitigation and monitoring costs of the environmental actions, benefits could not be quantified for environmental releases. A partial economic value is included in the annual water supply increment component that accounted for 10% environmental water required to comply with the 1997 USFWS Biological Opinion. The required releases or storage for environmental water need to be further quantified so that a monetary value can be assigned to this benefit. At present, it is difficult to give a value to the ecological benefits that will occur with the in-Delta storage project. No adjustments for habitat island releases have been included in the analysis.

CVPIA Benefits: In-Delta storage operations should be integrated with CVPIA requirements.

Water Transfers and Banking: There are no agreements between water users that can be applied to assessment of benefits. A storage apportionment agreement needs to be developed for this project.

Chapter 8
POLICY AND LEGAL ISSUES

8.1 Legal Issues

The CALFED ROD identifies in-Delta storage as a project that can help meet CALFED's objectives. As described elsewhere in this report, the in-Delta storage project would store approximately 217 TAF to provide fishery benefits and enhance water project flexibility. As a project identified in the ROD, the in-Delta storage project requires site-specific review and would tier from the Programmatic EIR/EIS. A question specific to the proposed CALFED in-Delta storage project is whether it is feasible for CALFED Agencies, through DWR, Reclamation, or some other member agency, to lease or purchase the currently proposed DW Project to satisfy the CALFED in-Delta storage goals (ROD p. 44.).

Several legal issues arise with respect to implementing the DW Project. These issues include: (1) what CEQA and NEPA document should the CALFED implementing agency prepare for implementing a CALFED In-Delta Storage Project, (2) what other permits or legal requirements might be needed before the DW project could be implemented, (3) what potential liability would the CALFED implementing agency be subject to if it purchased, leased, or agreed to water storage on the DW Project; and (4) does DWR have statutory authority to implement an in-Delta storage project. The following discussion addresses these legal issues. Throughout the discussion, it is assumed that DWR and/or Reclamation would implement the DW Project, if feasible, or an alternative to it, as the implementing and funding agency for in-Delta storage under the CALFED Implementation MOU.

8.2 CEQA Documentation Required for In-Delta Storage Project

The SWRCB and USACE prepared, through Jones & Stokes and Associates, an EIR/EIS for the DW Project. The SWRCB was required to prepare the CEQA document before approving DW's water rights application and the USACE required the EIS to approve a 404 application for construction of the Project. On February 15, 2001, SWRCB certified the Final DW Project EIR and adopted Decision 1643 approving DW's water rights application and issuing an order stating terms and conditions of the water rights permit. On Feb. 16, SWRCB filed a Notice of Determination giving notice of adoption of the Final EIR and the water rights decision. The USACE has not yet certified the EIS or issued a 404 permit although the 30-day comment period on the EIS is complete.

On March 16, 2001, Central Delta Water Agency (CDWA) and several Delta Reclamation Districts filed a lawsuit against the SWRCB challenging the adequacy of the CEQA document. On June 14, 2001, CDWA and others filed a second lawsuit against the SWRCB challenging the adoption of the water rights Decision 1643. Plaintiffs are alleging in the lawsuit that the EIR fails to: 1) adequately define the project scope to include users and uses of the water appropriated for the DW project; 2) include adequate alternatives analysis, (such as upstream reservoirs that would avoid impacts); 3) include adequate mitigation measures as to impacts on levee stability, seepage to surrounding lands, impacts on agricultural productivity, water quality, and fishery resources; and 4) describe and evaluate potential environmental impacts from use of water appropriated for DW project. The substantive issues of the lawsuit were heard in court in February 2002. In April 2002, the court upheld the SWRCB permit.

If the Court decision is appealed and the litigation is not resolved, the CALFED agencies analysis of the Project and use of the DW EIR can go forward. CEQA Guidelines State that the final EIR prepared by a lead agency shall be conclusively presumed to comply with CEQA for purposes of use by responsible agencies unless the court finds the document does not comply with CEQA or conditions require a subsequent EIR (CCR, Title 14 Section 15231). So until a court finds the DW EIR does not comply with CEQA, DWR may rely on it. As a project proponent relying on approvals based on the EIR, however, DWR would take a risk that the CEQA challenge may later affect the project and require additional documents.

CEQA regulations provide that DWR may assume the lead agency status of the DW Project and CEQA document as the next agency with responsibility to undertake or approve the Project. The SWRCB was lead agency but completed its grant of necessary approvals for the project and this approval need not be reopened by DWR (CCR, Title 14 Sections 15162).

Pursuant to NEPA regulations, Federal agencies may adopt Federal draft or final EISs or portions thereof if the EIS is adequate (Code of Federal Regulations, Title 40, Section 1506.3). If the original action described in the EIS is substantially the same as the proposed action, the agency adopting the EIS is not required to recirculate the document. If the proposed action and the action described in the EIS are not substantially the same, then the adopting agency must treat the document as draft and recirculate it.
If DWR determined no modifications were necessary to implement the DW project and assumed lead agency status, it could rely on the existing EIR to make findings for approving acquisition and implementation of the Project. It could issue a Notice of Determination as lead agency to acquire and construct the project. However, this situation is unlikely because, as discussed in this Report, DWR must consider some changes in the DW Project to implement the CALFED in-Delta storage project. Project changes include operational considerations in order to integrate DW operations with SWP and CVP operations. Moreover, the EIR and the biological opinions for the DW Project do not address the impacts of exporting the DW water at the SWP/CVP Delta pumping facilities. Because impacts of the specific use of the water have not been analyzed and disclosed in an environmental document, Reclamation/DWR would need to conduct additional analysis pursuant to CEQA and NEPA on this aspect of the Project.

The following discussion on CEQA requirements assumes that the DW Project would require modification and therefore may require additional documentation. Even with this assumption, DWR could use the DW Project EIR by adding to it and preparing a supplemental EIR. Or, DWR could prepare a subsequent EIR containing new information and referencing the DW EIR to make use of existing information and analysis. In addition, although not discussed below, NEPA issues would be similar to those of CEQA. Since the EIS has not yet been finalized, however, a federal lead agency for an in-Delta project, such as Reclamation, may consider revising the Draft EIS to satisfy any project changes that may be necessary for implementation.

The type of additional CEQA documentation that could be required if the DW Project required modifications will depend on the type of environmental impact the project changes might cause. If DWR determines through an initial study of the changes that these would not cause any new potential impacts, no further document would be needed. (Laurel Heights Improvement Association v. Regents of University of California (1993) 6 Cal. 4th 1112 (Laurel Heights II); River Valley Preservation Project v. Metropolitan Transit Development Board (1995) 37 Cal. App. 4th 154; Benton v. Board of Supervisors of Napa County (1991) 226 Cal. App. 3d 1467.) Where project modifications may cause potential environmental impacts, DWR could prepare three types of additional CEQA documentation: a subsequent EIR, a supplement to the DW EIR, or an addendum to the DW EIR. These three options are discussed below.

DWR must prepare a “subsequent EIR” if DWR determines there are substantial project changes, or circumstances with respect to the project substantially change, or new information of substantial importance is available, and these changes cause significant new impacts not previously disclosed in the DW EIR. A subsequent EIR would be subject to the same procedural and public participation requirements of a project EIR. (PRC Section 21166 and CCR Title 14, Section 15162.) DWR could attempt to confine the scope of the subsequent EIR, but the public and decision-makers may use the subsequent EIR to question the overall project. DWR could choose to rewrite the entire EIR or could prepare a more limited document addressing the changes and incorporating by reference the prior EIR, which could be attached to the new document.

DWR could prepare a “supplement” to the EIR if the substantial changes, as described above, constitute only minor additions or changes. The supplemental EIR need contain only information necessary to addresses the changes and make the EIR adequate. The supplemental EIR must be noticed and circulated for public review the same as a draft EIR, but neither a notice of preparation nor a response to comments document is required.

Finally, DWR could prepare an “addendum” to the DW EIR if proposed changes are minor technical changes or additions and do not cause a significant impact. An Addendum is sometimes prepared where the project has not yet been approved or to alter mitigation measures that does not change environmental impacts. An Addendum does not need to be circulated for agency or public review.

In addition to the possible additional CEQA documents that DWR may need to prepare, DWR could link the CEQA document for the in-Delta storage project to the CALFED Programmatic EIR/EIS as a “tiered” document. As a tiered document, the DW Project EIR/EIS would incorporate the analysis of regional effects, cumulative impacts, and broad alternatives that apply to the program as a whole. The project EIR could also include any applicable mitigation measures of the Programmatic EIR/EIS that might be required for cumulative impacts. For example, any significant impacts to agriculture for loss of land that have not been mitigated could be addressed through the CALFED Programmatic mitigation proposal (See Appendix A of ROD).

Although many formats of CEQA documentation are possible, DWR should choose the document that will provide the most complete analysis of the potential environmental impacts in order to withstand judicial scrutiny. The DW in-Delta storage project has been controversial and the proposed project selected by DWR also could be challenged in court. DWR experience with CEQA documentation indicates that the more complete the initial environmental documentation, less time and money will be spent over the long-term on such costs as litigation or dispute resolution.

A conservative recommendation, therefore, would be for DWR to assume lead agency status of the SWRCB EIR and prepare a subsequent EIR that addresses any changes in the project, changes in circumstances, and new information on the project since it was approved by the SWRCB. Another benefit of preparing a subsequent EIR is if the CDWA lawsuit challenging the adequacy of the DW Project EIR is successful, DWR may have less work later to correct any deficiencies found by the court.

8.3 Other Permits or Legal Requirements Needed to Implement DW Project

DW has obtained many permits and agreements for purposes of implementing its in-Delta storage project as described in its EIR. These permits were obtained as part of the SWRCB approval of the water rights application and EIR. DW permits for the project include: SWRCB water rights permit, federal Endangered Species Act (ESA) biological opinions, CESA permit, Programmatic Agreement for protection of historical and cultural resources, and Clean Water Act 401 certification. If Reclamation/DWR were to acquire or be responsible for implementing the project, it would be responsible for complying with the project permits. DW and Reclamation/DWR would need to notify the permitting agencies that DWR has acquired the permits as part of the project.

Under the existing permits, however, if project conditions change, the permits may require amendments. In the case of the ESA biological opinions, Reclamation/DWR may need to reinitiate consultation on changes that may effect endangered species. In the case of the NMFS opinion for the DW Project, NMFS did not include incidental take authorization for the rediversion of DW discharges by other parties, such as rediversion at the CVP and SWP Delta facilities. (NMFS 1997 and transmittal letter from NMFS to U.S. Army Corps (May 8, 1997).) Therefore, for the permits already obtained for the DW Project, DWR will need to review each permit with the permitting agency to determine if new conditions may be necessary before implementing the project.

In addition to the existing permits already obtained by DW, DWR may need to obtain a permit from DWR’s Division of Dam Safety if the reservoirs will store water 4 feet above MSL (Water Code Section 6004). DW has not yet pursued this permit as it first needed to obtain the water right permit. After a water right is secured for a new storage reservoir, the project proponent then must apply to the Division of Dam Safety to obtain a permit before constructing a reservoir within its jurisdiction (California Code of Regulations, Title 23, Section 303).

With respect to the water rights permit for the DW Project Islands, DWR or Reclamation will need to consider if the in-Delta storage project that is proposed will use the water as permitted within the terms and conditions of Decision 1643. If Reclamation/DWR acquire the DW property, Reclamation/DWR would have the right to use the water appurtenant to those lands pursuant to established rights. California law presumes that water rights pass with the transfer of land unless expressly excepted (See CCR Title 23, Section 833.) Assuming that DW would not reserve the water right to itself, as prior owner of land that is sold, DW would be required to file a statement of the transfer with the SWRCB stating the name and address of the new owner and the application number of the water right (CCR Title 23, Section 831).

The DW water rights obtained for the storage project include the right to divert at several points of diversion from adjacent channels onto Webb Tract and Bacon Island and the right to redivert the water at three export locations, the CVP Tracy Pumping Plant, the SWP Banks Pumping Plant, and/or the Contra Costa Canal Pumping Plant. The permit requires that the project construction be completed and water use begun by December 31, 2011. The authorized place of use of the water is the CVP and SWP service areas and the Bay-Delta estuary (D-1643 conditions 1 – 5.) The permit includes many requirements and constraints on use of the water, such as specified seasons of diversion, limits of amounts diverted, compliance with water quality and fish protection criteria, and reporting and monitoring requirements. The permit prohibits filling the storage reservoirs above MSL until the permittee can demonstrate to the SWRCB's Chief of Division of Water Rights that the water can be wheeled and that it has contracted with at least one entity for delivery of the water (D-1643 conditions 21 and 34(b)).

No new water rights were obtained for Bouldin Island and Holland Tract. These islands will use existing water rights for implementing the HMP proposed as mitigation for construction and operation of the reservoir islands. The water rights for Webb and Bacon Islands, however, are conditioned on the continued operation and management of the habitat on Bouldin and Holland pursuant to HMP (D-1643 condition 25(g)).

If Reclamation/DWR were to implement the DW Project as described in the water rights permit, it probably would not need to request any further action by the SWRCB. However, if Reclamation/DWR propose a modified in-Delta storage project, it is likely Reclamation/DWR would need to file a petition with the SWRCB addressing any changes in points of diversion, place of use, or purpose of use. The need to petition the SWRCB will depend on the type of change needed and whether the change may be allowed under the existing permit conditions. For example, if the CALFED alternative chosen for in-Delta storage proposed diverting water onto Victoria Island instead of Webb Tract, Reclamation/DWR would need to petition the SWRCB for a change in point of diversion of the water (Water Code Section 1701.) The SWRCB would most likely obtain protests regarding the petition and would need to convene a water rights hearing before it could approve the change (W.C. Section 1704). Changes in proposed mitigation, such as implementation of the HMP on Bouldin Island or Holland Tract would require returning to the SWRCB to modify the permit conditions. Even if Reclamation/DWR did not make changes to the DW Project, it is possible that further SWRCB action might be needed to address unanticipated problems, such as with water quality or fish impacts. The SWRCB has retained continuing authority to impose additional terms as needed for drinking water quality protection, levee design and seepage control systems, fish protections, and protection of beneficial uses in general (D-1643 conditions 9 and 35).

In addition to permits, DW agreed to several settlement agreements with other agencies. These settlement agreements specifically apply to any subsequent owners or operators of the DW projects. DWR would be required to comply with these agreements, such as the East Bay Municipal District (EBMUD) Agreement to protect fish on the Mokelumne River and the CUWA agreement to protect drinking water quality from DW discharges. DWR may also need to enter into additional agreements to address issues not resolved by DW. For example, PG&E has concern that the project may impact its two gas pipelines from flooding of Bacon Island. The DW water rights permit from the SWRCB requires the permittee to obtain an agreement with PG&E or court judgment stating that the permittee has a right to construct a reservoir and fill it with water (D-1643 condition 22). Therefore, prior to operating the storage project, DWR must obtain an agreement from PG&E to resolve any conflicts regarding potential project impacts and responsibility to mitigate such impacts. If DWR and PG&E cannot reach agreement, a court proceeding might resolve the issue. As with all issues surrounding potential conflicts with the construction and operation of the in-Delta storage proposal, the problems are fact specific and will require detailed analysis of the proposed storage project and the rights of the affected entity, such as PG&E.

8.4 Potential Liability of Implementing Project

The CALFED ROD requires that DWR explore the lease or purchase of the DW Project. In addition to these two options, DWR considered whether it could enter into an agreement with DW for water purchase or water banking. DWR should consider, along with technical issues, whether any of these options might be more feasible than another because of differences in potential liability.

Reclamation/DWR could purchase the DW project land and construct the project. As landowner and operator, Reclamation /DWR would be subject to potential damage claims as permitted by law. Such potential claims could include permit violations or harm to persons or property resulting from negligent operations of the project. Such potential liability would be similar to the potential DWR experiences as operator and owner of lands and facilities associated with the State Water Project. An advantage to purchasing the project is that Reclamation/DWR would have maximum control over design and construction and could construct a project that it believes would minimize future risk of liability associated with operations. The disadvantage is that Reclamation/DWR would be subject to costs of claims arising from the Project under its control.

The potential for liability associated with hazardous material on the property, however, could be reduced by requiring that DW take responsibility for site cleanup before Reclamation/DWR acquire the land. Prior to acquisition, Reclamation/DWR could have a hazardous materials site inspection performed to diligently investigate if any hazardous contaminants are present. DW would be required to remove any contamination as a condition of acquisition.

If Reclamation/DWR were to lease some portion of the DW Project, DWR’s potential liability would depend on the type of lease arrangement. A lease could be written that assigned responsibilities for construction and operation of the Project under several different arrangements. For example, Reclamation/DWR and DW could agree to share construction responsibilities, apportion funding, and provide for limited term water purchase provisions. Or, DW could construct the Project and Reclamation/DWR could agree to operation of the Project with certain payment terms covering costs of water and construction. Or, Reclamation/DWR could agree to purchase water developed from the DW project for five years during which potential problems with water quality and environmental impacts could be studied. If the studies determined that these issues were not a concern, then Reclamation/DWR could be required to enter into a long-term water purchase agreement or purchase the project in whole. The terms of such agreements would influence Reclamation/DWR’s potential liability for the Project. During negotiations in developing a lease agreement, each party of the lease would consider its risk of future liability associated with its responsibilities under the lease. Such risk analysis is used when considering the benefits and costs of the transaction. It is possible Reclamation/DWR risk of liability could be reduced in a lease, but this probably would be one of many considerations when deciding the best arrangement for Reclamation/DWR to implement the CALFED in-Delta storage program.

If DWR were to simply lease the land from DW and then construct and operate the project, it might have similar potential long-term liability to that as a landowner. The amount of risk of liability would depend on the lease agreement and the extent of DWR’s involvement in constructing the project. If DWR took control over project construction to assure that the project would be constructed to the highest standards possible and was solely responsible for operating the project, its potential liability would probably be as great as if it owned the land under the Project. As a general rule, a lessor, such as DW in this case, would not be liable for the acts of its lessee where the landowner is not in possession and control of the property (O’Leary v. Herbert (1935) 5 Cal. 2d 416).

In contrast, Reclamation/DWR could minimize its potential liability if it agreed to only purchase water developed by DW. The purchase agreement would define responsibilities, but the risk of liability for operation and maintenance would most likely be less for Reclamation/DWR than for DW in a water purchase arrangement.

8.5 DWR Authority to Construct In-Delta Storage Project

The Burns-Porter Act (Water Code Section 12930 et seq.) and the Central Valley Project Act (Water Code Section 11100 et seq.) (together "Acts") provide authority for DWR to acquire land and construct an in-Delta storage facility. The Acts grant DWR broad authority to develop and construct the SWP in conjunction with the CVP.

> The Acts grant DWR authority to construct and maintain a State Water Resources Development System, also known as the SWP, composed of a variety of water facilities. "State Water Facilities" are defined as:
>
> "Master levees, control structures, channel improvements, and appurtenant facilities in the Sacramento-San Joaquin Delta for water conservation, water supply in the Delta, transfer of water across the Delta, flood and salinity control, and related functions." Water Code Section 12934(d)(3).
>
> The proposed CALFED in-Delta storage project would store and distribute water for possible uses of "supply," "conservation," and "salinity control" through a variety of "levee" systems and "control structures." As defined by the Acts, these uses and facilities come within DWR's existing authority to construct the SWP. The In-Delta storage project also could be considered an "appurtenant" facility of DWR's SWP because it would be physically connected and operationally integrated with, and thus appurtenant to the SWP.

Under other sections of the Water Code, DWR has authority to acquire and construct additional facilities as part of the SWP, "including such other additional facilities as the department deems necessary and desirable to meet local needs, including, but not restricted to, flood control, and to augment the supplies of water in the Sacramento-San Joaquin Delta…" (Water Code § 12931). This discretionary authority is also recognized in another section of the Act which authorizes funding for construction of additional facilities the department determines necessary to meet local needs and to augment supplies of water in the Sacramento-San Joaquin Delta from multiple purpose dams, reservoirs, aqueducts and appurtenant works (Water Code Section 12938).

The California Supreme Court in *Metropolitan Water Dist of So. Cal. v. Marquardt* (1963) 59 Cal.2d 159, 28 Cal.Rptr. 724, recognized DWR's discretionary authority to determine necessary additional facilities pursuant to Water Code Sections 12931 and 12938. The Court concluded that the facilities authorized in these Sections are in addition to those enumerated in Section 12934(d) and include such other facilities as DWR deems necessary and desirable to meet local needs or to augment the supplies of water in the Delta. The in-Delta storage project could reasonably be considered an additional facility as described within the statute and case law. The law supports the conclusion that DWR has existing authority to acquire lands and construct an in-Delta storage project, such as the DW Project.

8.6 Permits and Approval

Information on permits and approvals required for complete implementation of the project is given in Table 31.

Table 31
PERMITS AND APPROVALS REQUIRED FOR IN-DELTA STORAGE PROJECT

Agency and Regulation	Required Authorization	Project Activity
FEDERAL		
U. S. Army Corps of Engineers Clean Water Act (Section 404) EPA Section 404(b)(1) Guidelines	The USACE permit for discharge of dredged or fill material into waters of the United States, including wetlands	Construction of levees, reservoir, inlet and outlet works, and conveyance facilities
Rivers and Harbors Act of 1899 (Sec 10)	The USACE permit for activities in or affecting navigable waters	Construction of levees, intakes, pumps and fish screens and recreational facilities
U.S. Bureau of Reclamation Petition to amend water rights	Reclamation petitions SWRCB to modify rights to allow changes in diversion location quantity or rate	Diversion of Delta water exceeding existing water rights
Contract amendments or approvals	Reclamation amends contracts with water agencies and COA Agreement with the State	Modifications to CVP System, and changes in operation and maintenance and service area
U.S. Fish and Wildlife Service **National Marine Fisheries Service** Endangered Species Act (Section 7) Fish and Wildlife Coordination Act	Federal agencies consultation and approvals from USFWS and NMFS required for projects which may affect listed or proposed endangered or threatened species or critical habitat	Project implementation and activities affecting control and modification of surface waters
STATE		
California Dept. of Fish and Game Stream Alteration Agreement	DFG agreements with agencies proposing changes to rivers, streams or lakes	Construction of levees, reservoir, inlet and outlet works, and conveyance facilities
California Dept. of Water Resources Approval to use DWR Facilities	DWR evaluates and gives consent to agency plans to modify or tie into DWR facilities	Tie into Clifton Court Forebay and modifications to SWP Delta exports
Approval of plans and specifications	DSOD grants approval to plans and specifications	Design and construction of an in-Delta project
Notice of completion, actual cost statement and approval to impound water	DSOD evaluates safety of newly constructed or enlarged reservoir and grants approval to initiate storage operations	Storage of Project water
The Reclamation Board Encroachment Permit on project levees	The Reclamation Board reviews and grants approval to activities affecting the USACE flood control	Construction in designated USACE floodways and installing works affecting flood control projects
State Water Resources Control Board Permit to appropriate water rights and/or amendment to existing water rights	SWRCB issues permit to allow appropriation of water and grants approval to divert water to storage and to change purpose of use	Additional diversions and changes in points of diversion, storage and water uses for additional demands
Water quality certification pursuant to Section 401 of the Clean Water Act	SWRCB certifies that the applicant complies with the State's water quality standards	Construction of levees, reservoir, inlet and outlet and conveyance facilities
Regional Water Quality Control Board Waiver from discharge requirements	RWQCB's approval for project waste discharge into surface waters and projects affecting groundwater quality	Any earth-moving activities, discharge from dewatering into storm drains and creeks and wastewater from conveyance cleaning operations
State Lands Commission Dredging Permit and lease for encroachment on State lands	State Lands Commission issues a permit for dredging and deposit of material on State lands	Activities requiring use of State owned-lands for construction and siting of project facilities
California Dept. of Transportation Encroachment Permit	Caltrans issues encroachment permit for projects affecting right-of way of State-owned roadways	Conveyance facility crossings
Regional and Local Agencies and Utilities Encroachment and crossing permits	Counties, Cities, Irrigation Districts, Utility Companies and Railway entities issue permits	Construction of facilities affecting drainage, utilities and railway structures

APPENDIX - A
ABBREVIATIONS AND ACRONYMS

AFRP	Anadromous Fish Restoration Program
CALFED	California Federal Bay-Delta Program
CALSIM	California Simulation Model
CCWD	Contra Costa Water District
CESA	California Endangered Species Act
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CPT	Cone Penetrometer Test
CUWA	California Urban Water Agencies
CVP	Central Valley Project
CVPIA	Central Valley Improvement Act
CVPM	Central Valley Production Model
DBW	Department of Boating and Waterways
DFG	Department of Fish and Game
DO	dissolved oxygen
DOC	dissolved organic carbon
DOE	Division of Engineering
DBP	disinfection byproducts
DPC	Delta Protection Commission
DSOD	Division of Safety of Dams
DW	Delta Wetlands
DWR	Department of Water Resources
EBMUD	East Bay Municipal District
EC	electrical conductivity
E/I	export/inflow
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ESA	Endangered Species Act
EWA	Environmental Water Account
FMWT	Fall Mid-Water Trawl
FOC	Final Operations Criteria
HMP	Habitat Management Plan
ISI	Integrated Storage Investigations
LCPSIM	Least-Cost Planning Simulation Model
maf	million acre-feet
mg/L	milligrams per liter
MILP	mixed integer linear programming
MOU	memorandum of understanding
MSL	mean sea level
MWQI	Municipal Water Quality Investigations Program
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine and Fisheries Service
O&M	Operations and Maintenance
PEIS	Programmatic Environmental Impact Statement
PG&E	Pacific Gas and Electric
Reclamation	U.S. Bureau of Reclamation
ROD	Record of Decision
SMARTS	Special Multipurpose and Research Technology Station
SWP	State Water Project
SWRCB	State Water Resources Control Board

TAF	thousand acre-feet
TTHM	total trihalomethanes
TOC	total organic carbon
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VAMP	Vernalis Adaptive Management Plan
WQMP	Water Quality Management Plan
X2	The distance in kilometers above the Golden Gate of two parts per thousand salinity one foot above the bottom

APPENDIX – B

Figure 12: DELTA WETLANDS PROJECT DRAWINGS

FIGURE 12-1

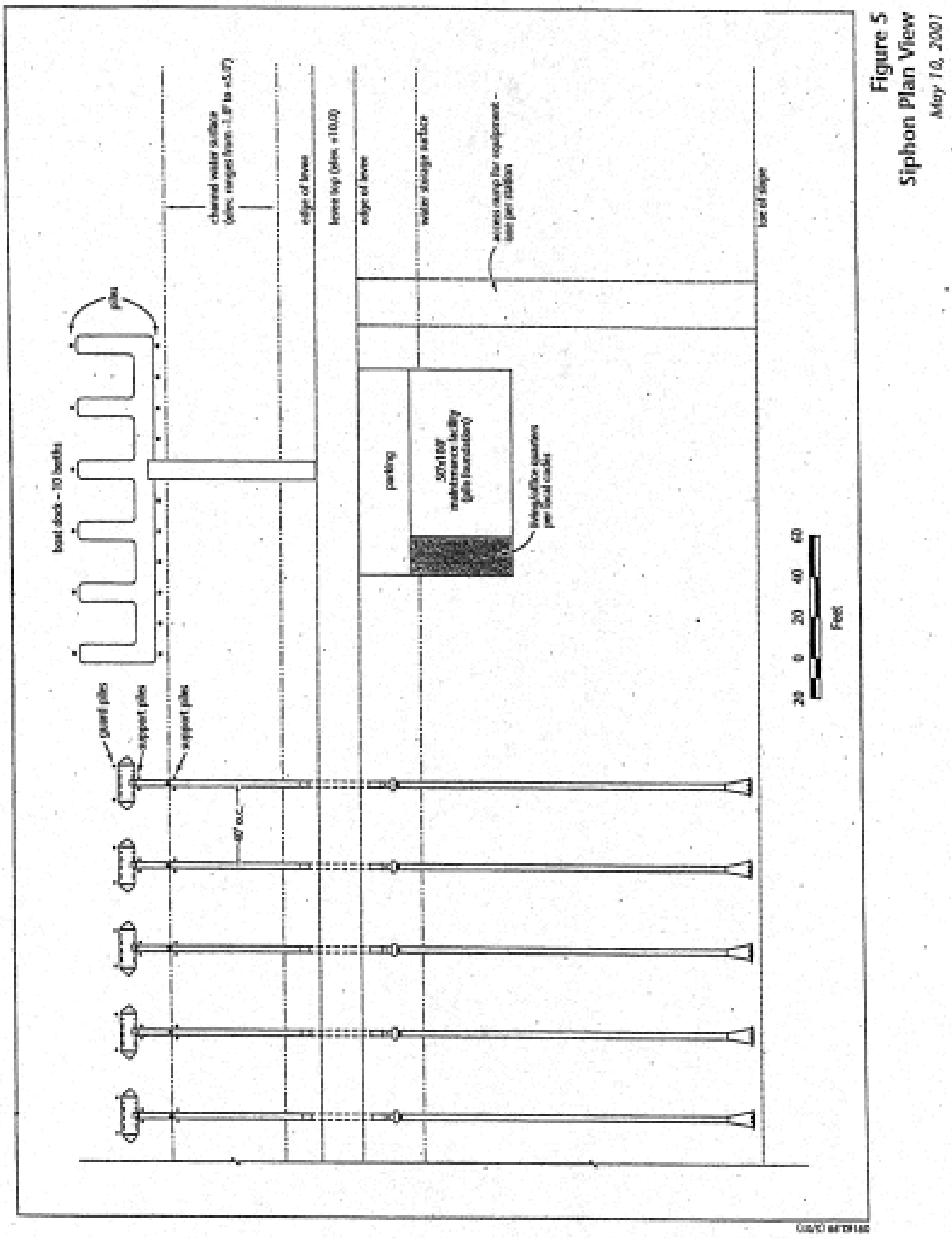

boat dock – 10 berths
piles
guard pile
support pile
support pile
40' o.c.
edge of levee
water storage surface
parking
toe of slope
Feet
Figure 5
Siphon Plan View
May 10, 2001

FIGURE 12-2

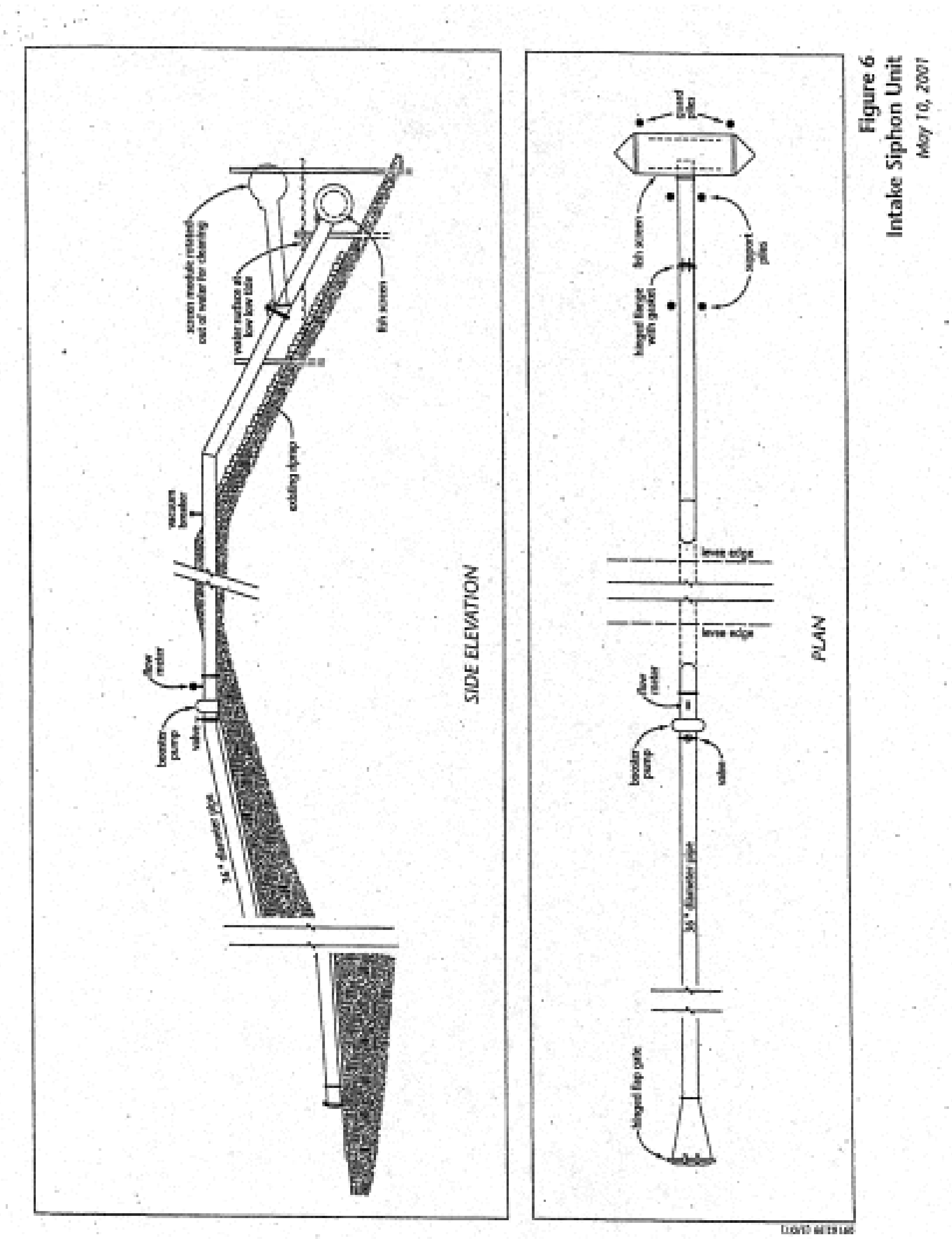


Figure 6
Intake Siphon Unit
May 10, 2001
SIDE ELEVATION
PLAN
levee edge
levee edge

FIGURE 12-3

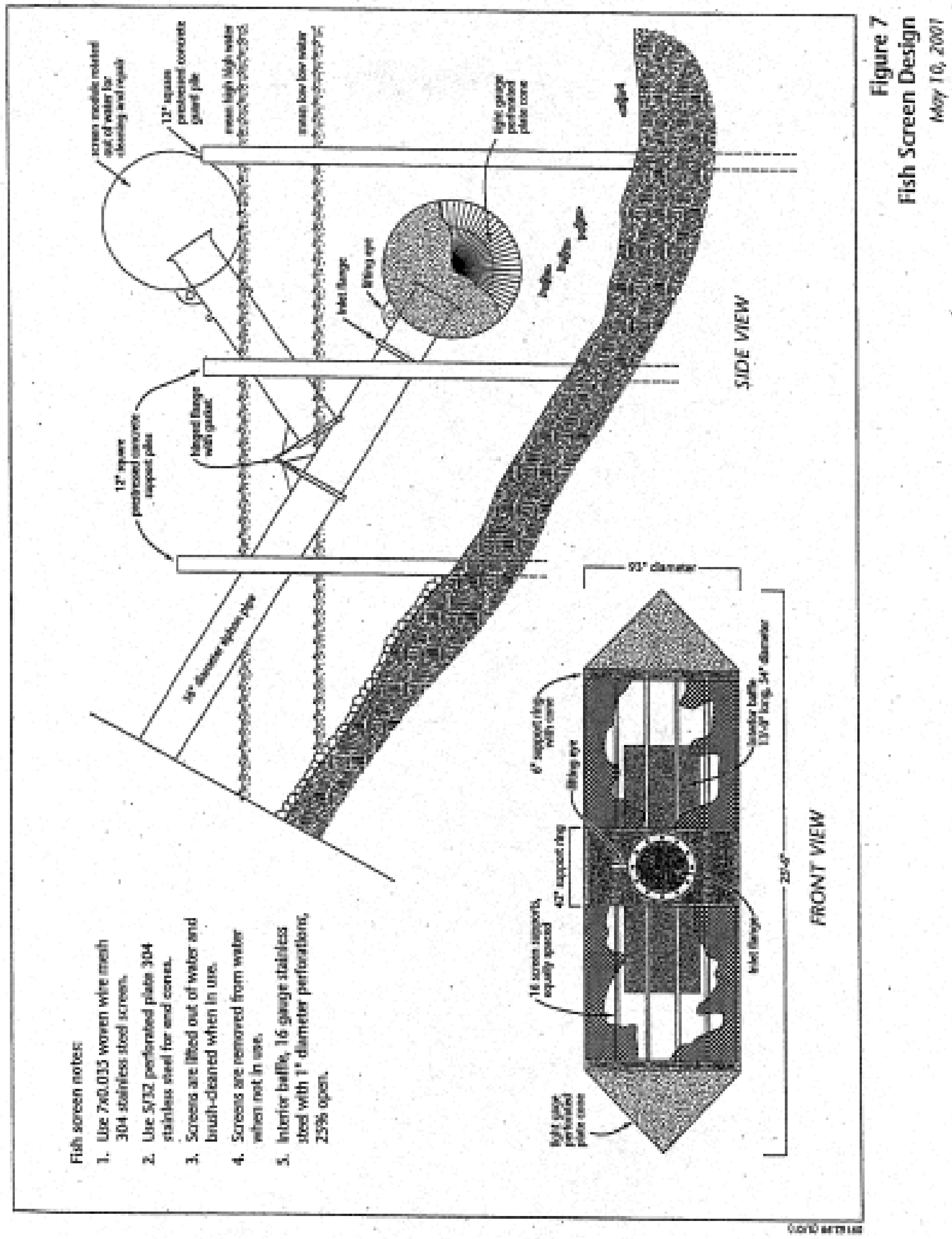


Figure 7
Fish Screen Design
May 10, 2001
SIDE VIEW
FRONT VIEW
Fish screen notes:
1. Use 7x0.033 woven wire mesh 304 stainless steel screen.
2. Use 5/32 perforated plate 304 stainless steel for end cones.
3. Screens are lifted out of water and brush-cleaned when in use.
4. Screens are removed from water when not in use.
5. Interior baffle, 16 gauge stainless steel with 1" diameter perforations, 23% open.

FIGURE 12-4

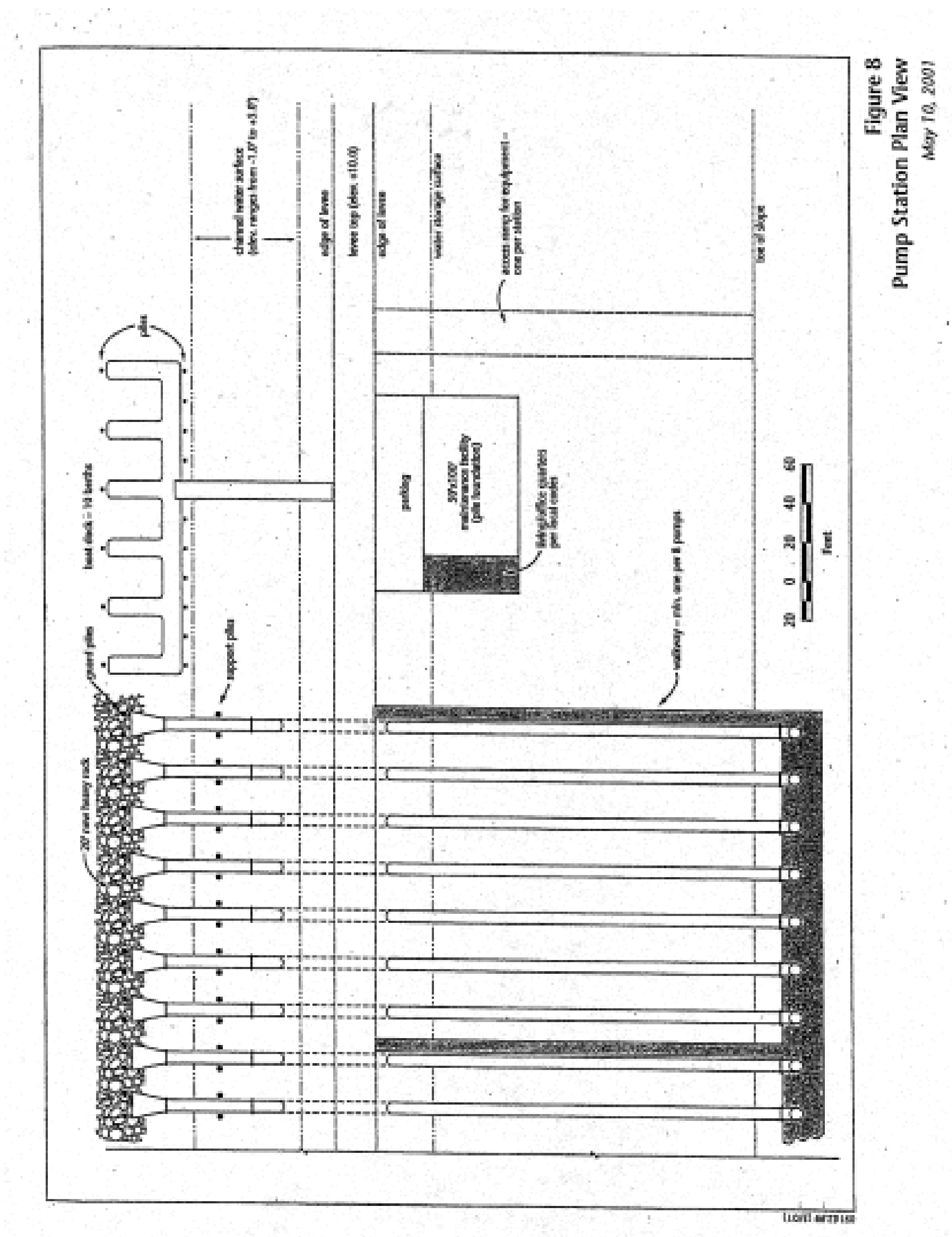
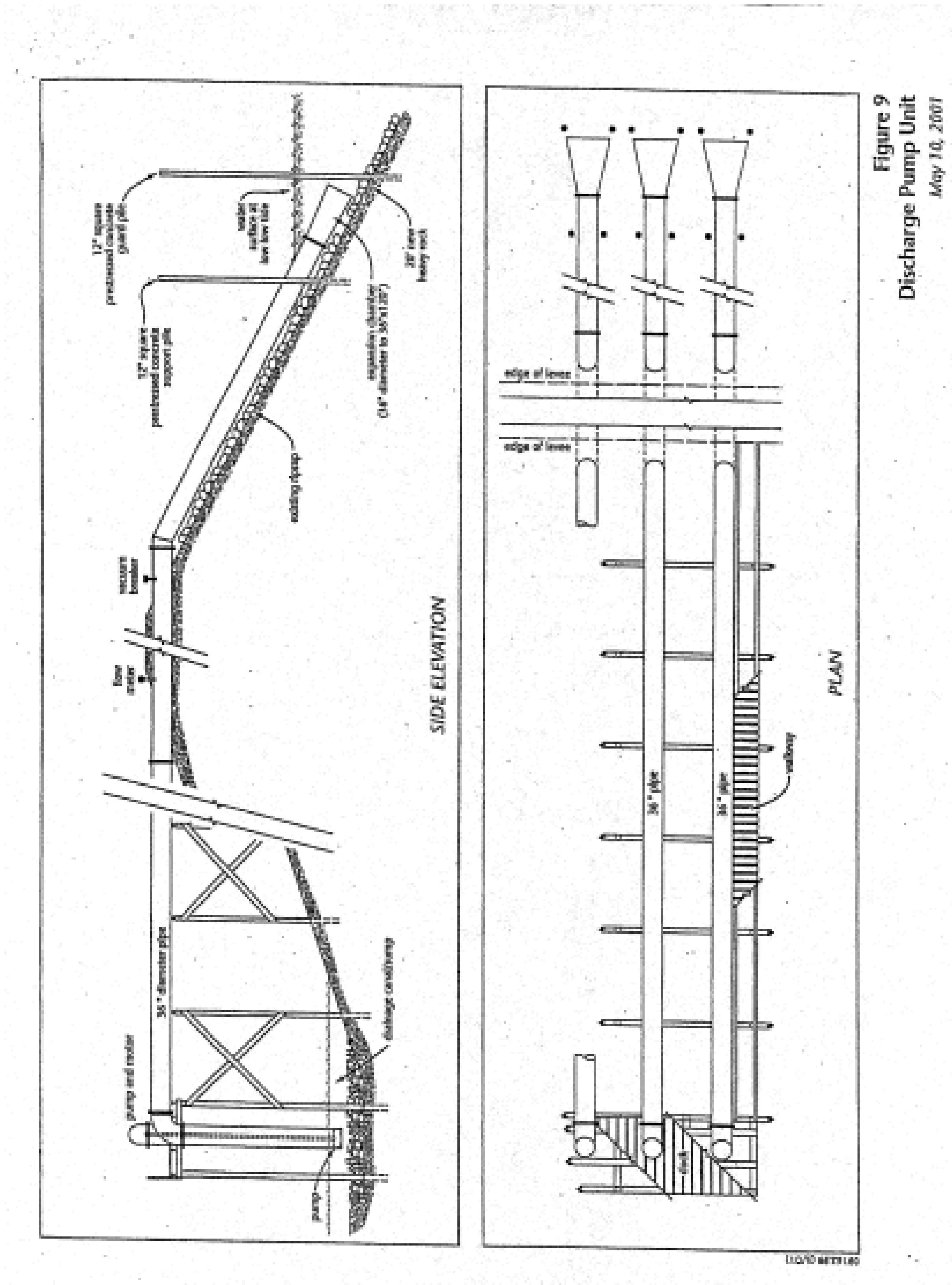


FIGURE 12-5



SIDE ELEVATION
PLAN
edge of levee
edge of levee
Figure 9
Discharge Pump Unit
May 10, 2001